The Survey of the MAgellanic Stellar History – SMASH

Knut Olsen (NOAO)

DECam Community Science Workshop

March 12, 2015

Image credit: Roger Smith

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- Kathy Vivas (CTIO)
- Alistair Walker (CTIO)
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Background

Many reasons to love the Clouds!

- 16,000+ papers include “Magellanic Clouds” in abstract
- Surveyed from radio to x-ray wavelengths
- Magellanic Stream clear evidence of interaction
- 30 Doradus largest star forming region in Local Group
- Background source for microlensing
- Key rung in distance ladder
- Host of SN 1987A

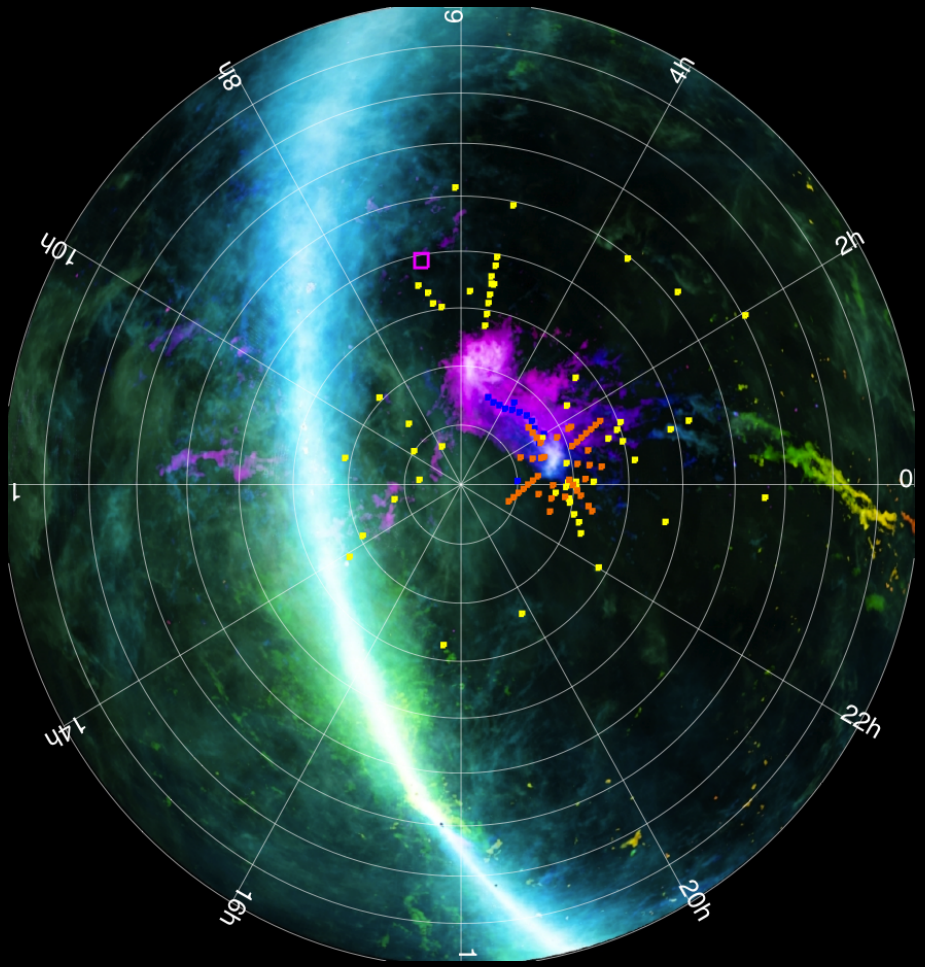
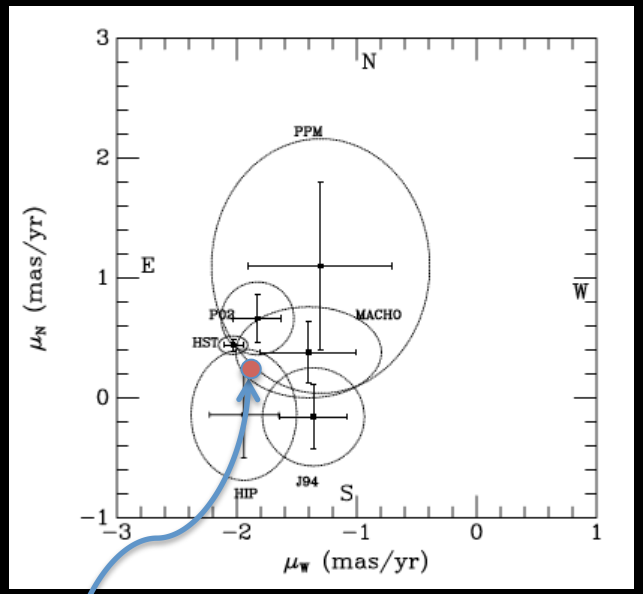


Image credit: S. Janowiecki and the Galactic All Sky Survey (McClure-Griffiths et al. 2009)

Still learning a lot!

- Geometry (e.g. van der Marel 2001)
- Magellanic Clouds on first infall or highly elliptical orbit (Kallivayalil et al. 2006, Besla et al. 2007)
- Magellanic Stream is 200+ degrees long (Nidever et al. 2010)
- Clouds extend a long way (Majewski et al. 2009, Saha et al. 2010)
- LMC and SMC may have collided directly ~200 Myr ago (Besla et al. 2012)
- LMC has stripped stars from the SMC (Olsen et al. 2011)
- Population gradients (Gallart et al. 2008, Meschin et al. 2014)
- Dwarf satellite population! (Koposov et al. 2015, Bechtol et al. 2015)



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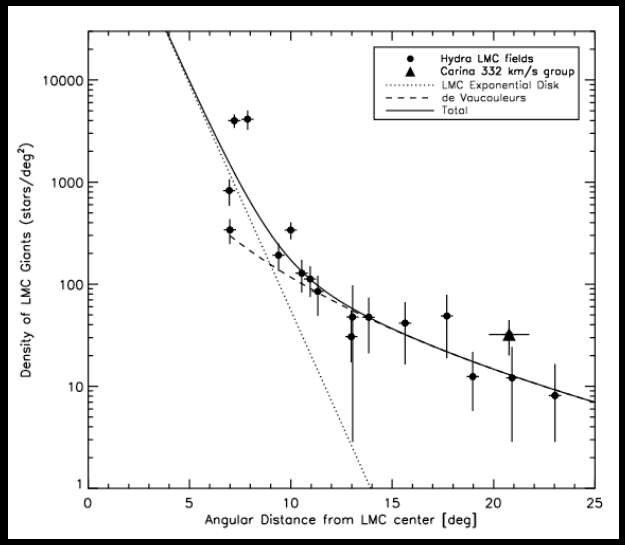
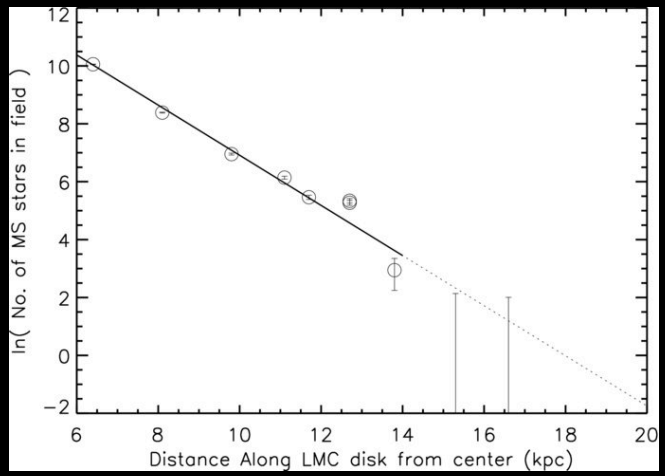


Saha et al. (2010)



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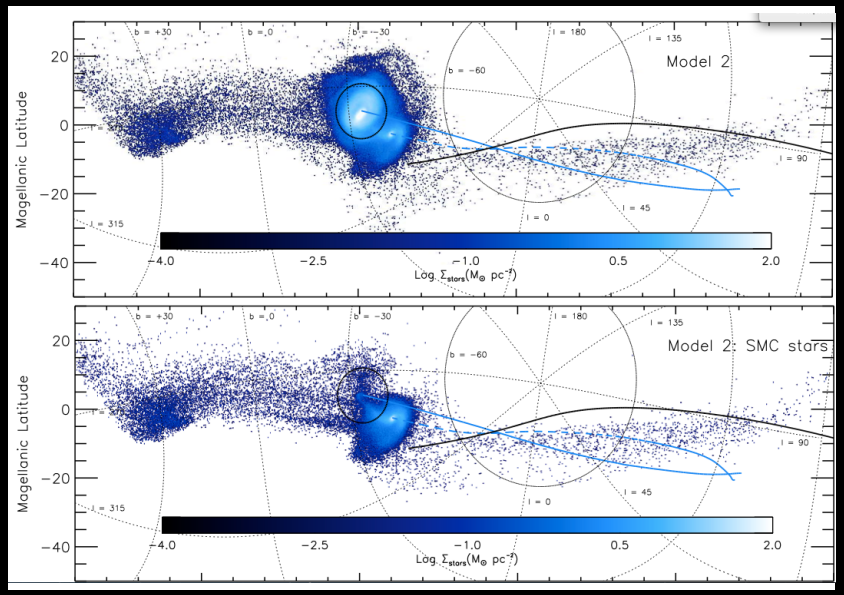

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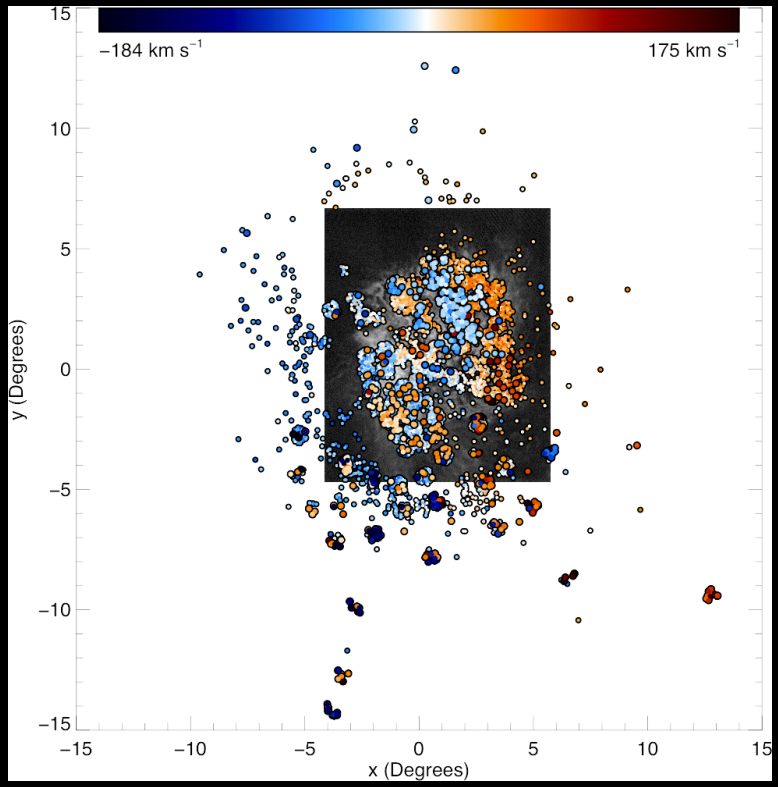
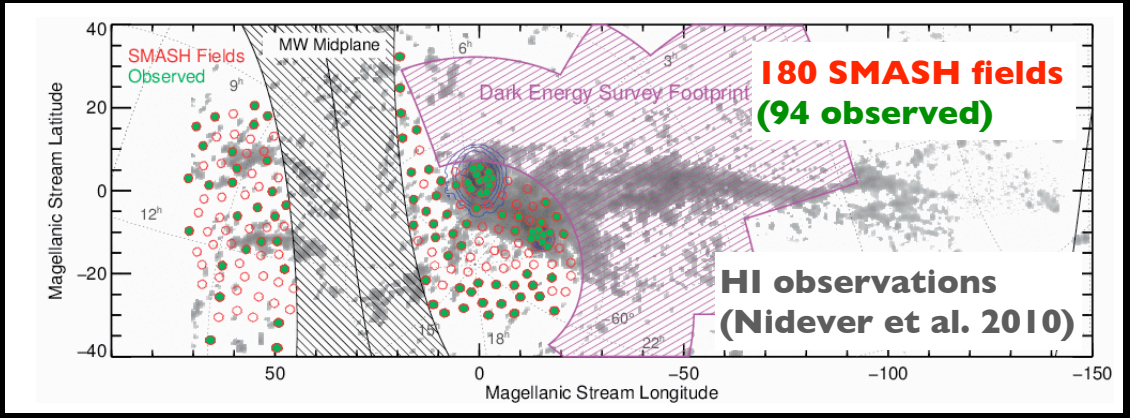
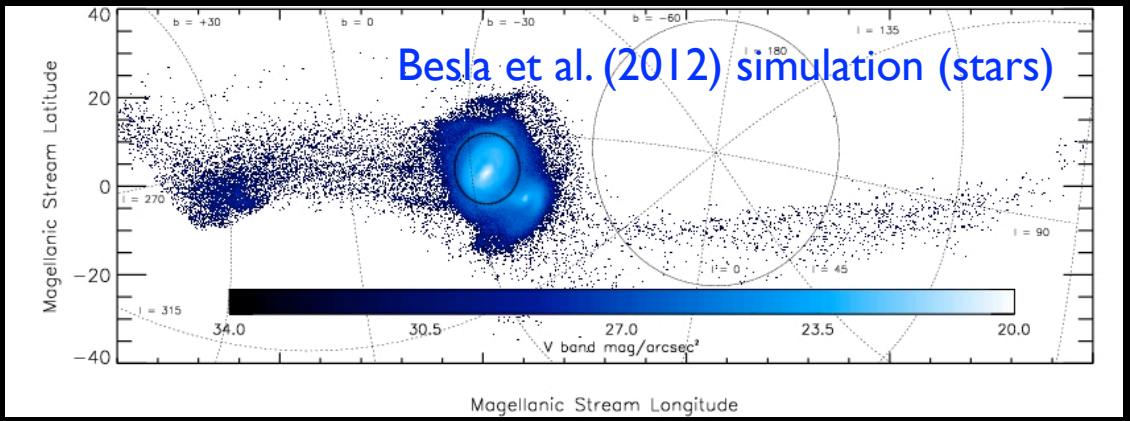


Olsen et al. (2011)

SMASH





- PI: Nidever
- SMASH is probing for structure through a 480 square degree survey spread over an area of 2400 square degrees
- 178 fields, *ugriz*~24 (S/N=10-20), 42 4-m nights, 28 0.9-m nights (calibration)
- Expect catalog of ~250 million objects

Goals

Main goals:

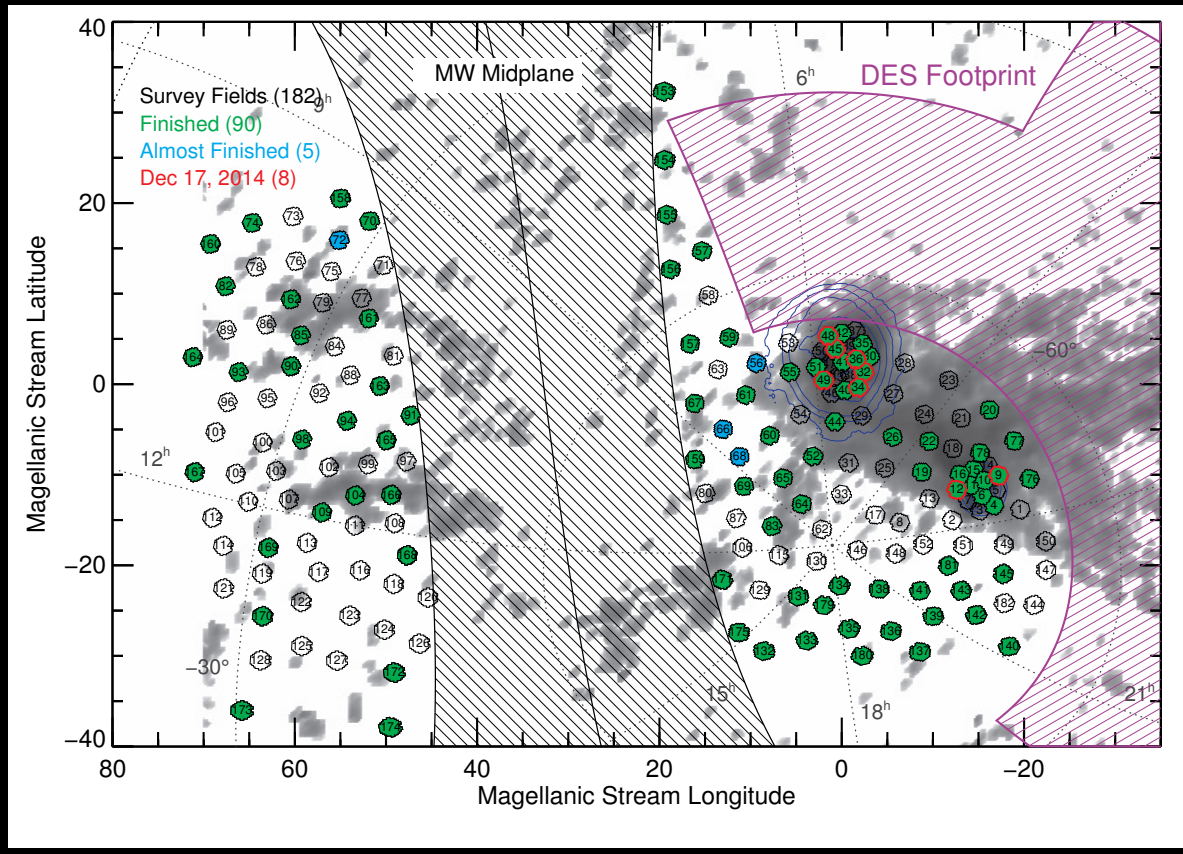
1. Search for the stellar component of the Magellanic Stream and Leading Arm
2. Detect and map extended stellar components of the Clouds including halos and tidal debris
3. Derive spatially resolved, precise star formation histories covering all ages of the MCs and to large radii

Additional goals:

1. Magellanic Cloud star cluster population
2. Galactic structure

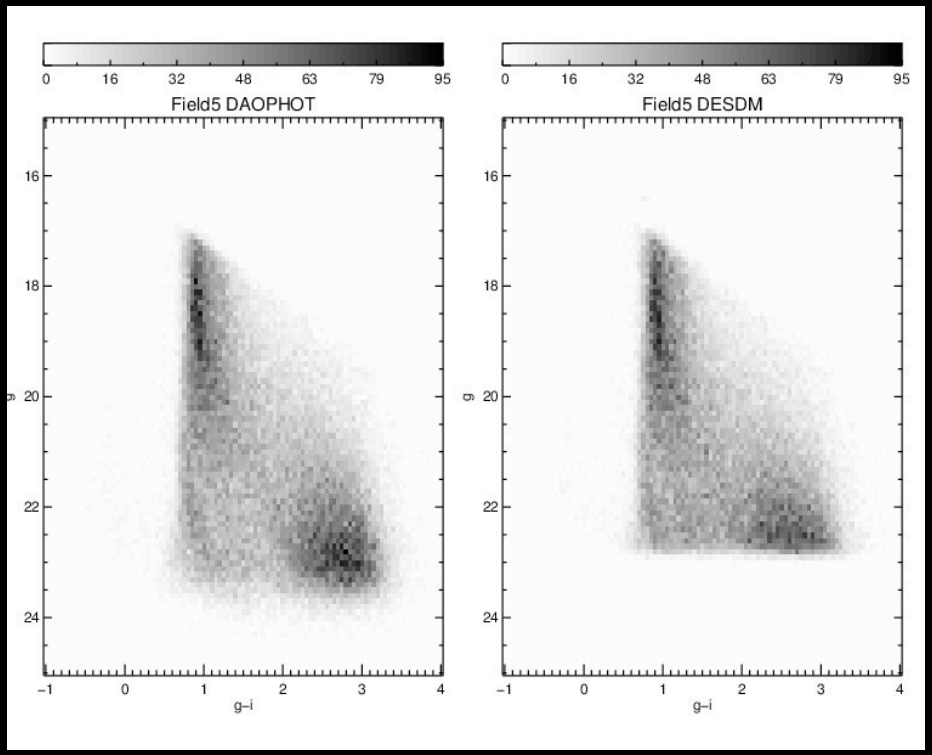
Observing Strategy

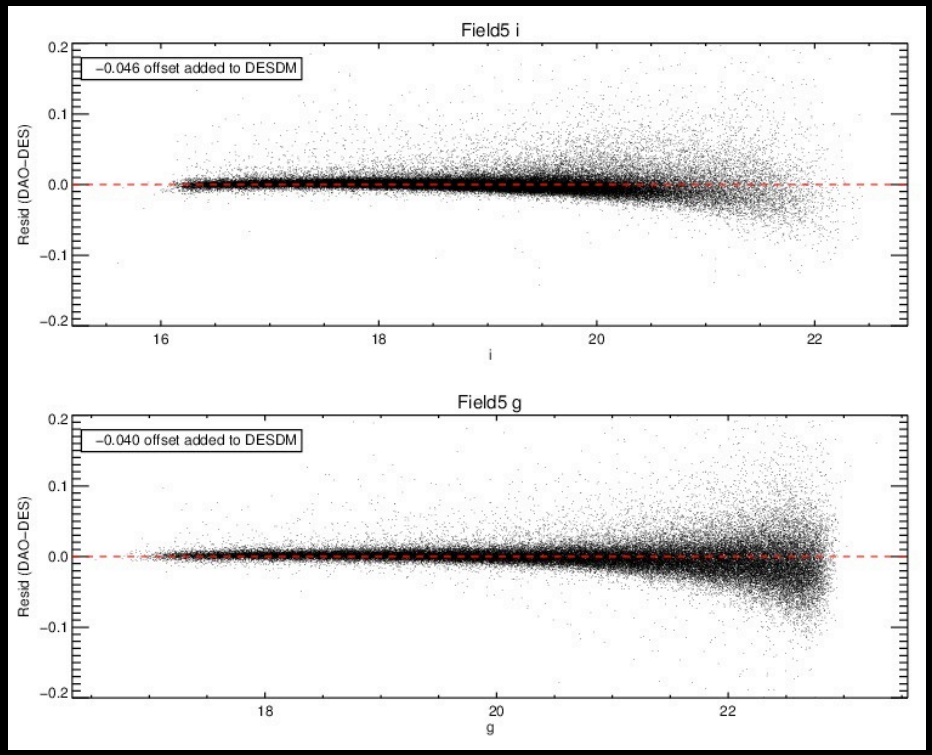
- Most of our fields are non-overlapping
- Observe complete fields in one shot to minimize overhead
- Reserve best seeing for overlapping main body fields
- Each field has three deep exposures per filter with small (5 arcsec) dithers
- Three shallow exposures per filter with half-chip dithers



Photometry

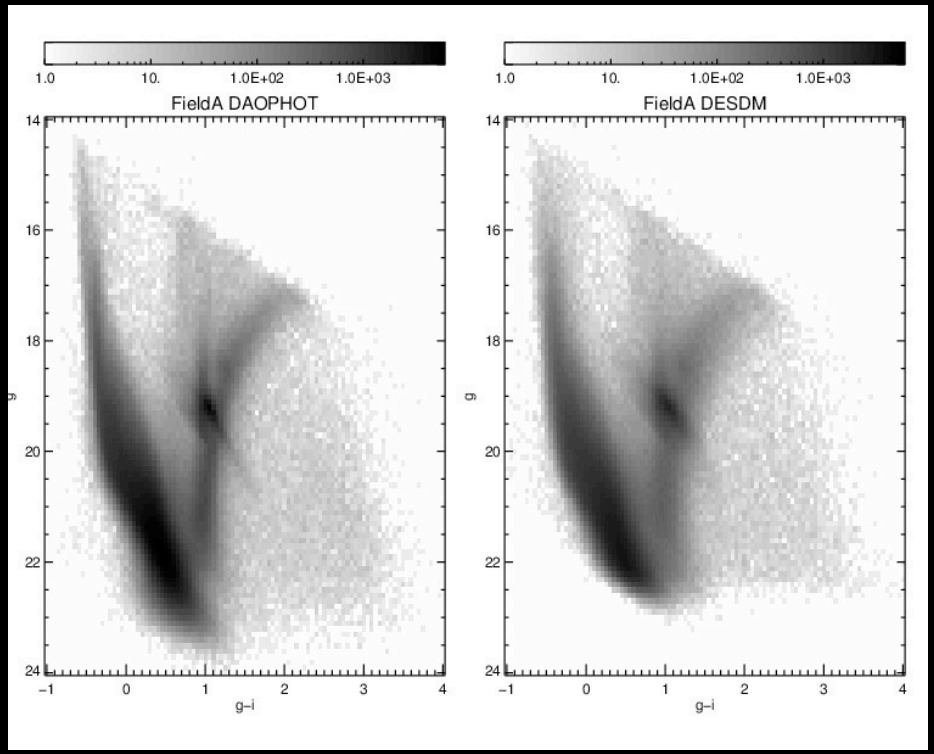
- Plan A was for team member Robert Gruendl to process data through DESDM pipeline
- DESDM performs well for most fields for single exposures
- Our observing strategy makes it painful to extract full depth photometry

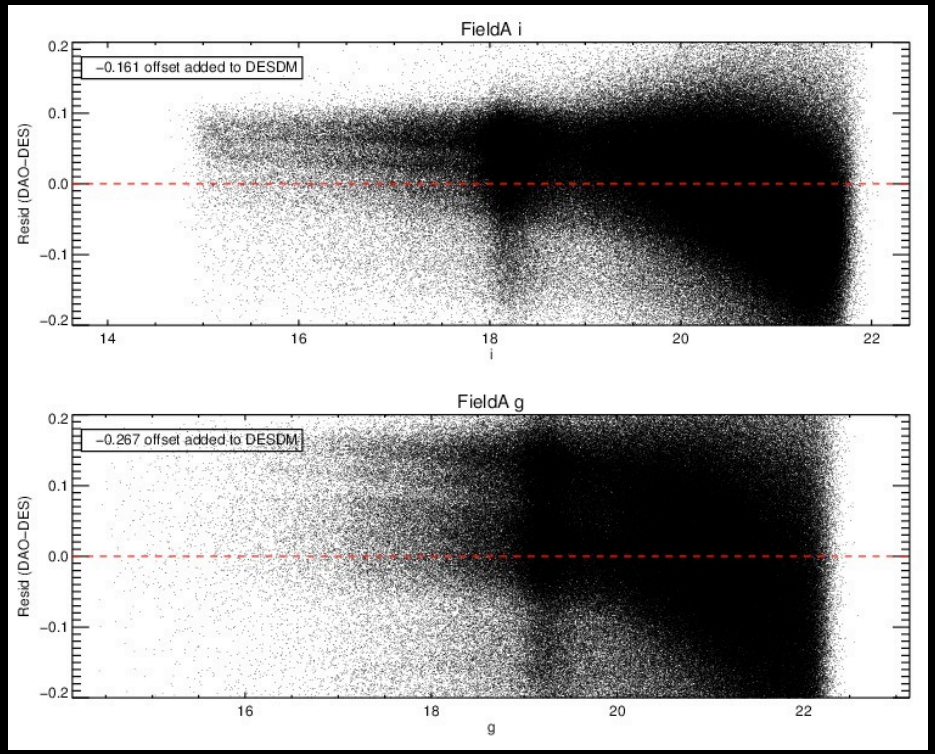




Photometry

- DESDM in default configuration has problems in crowded fields
- Plan B to process data through alternate means





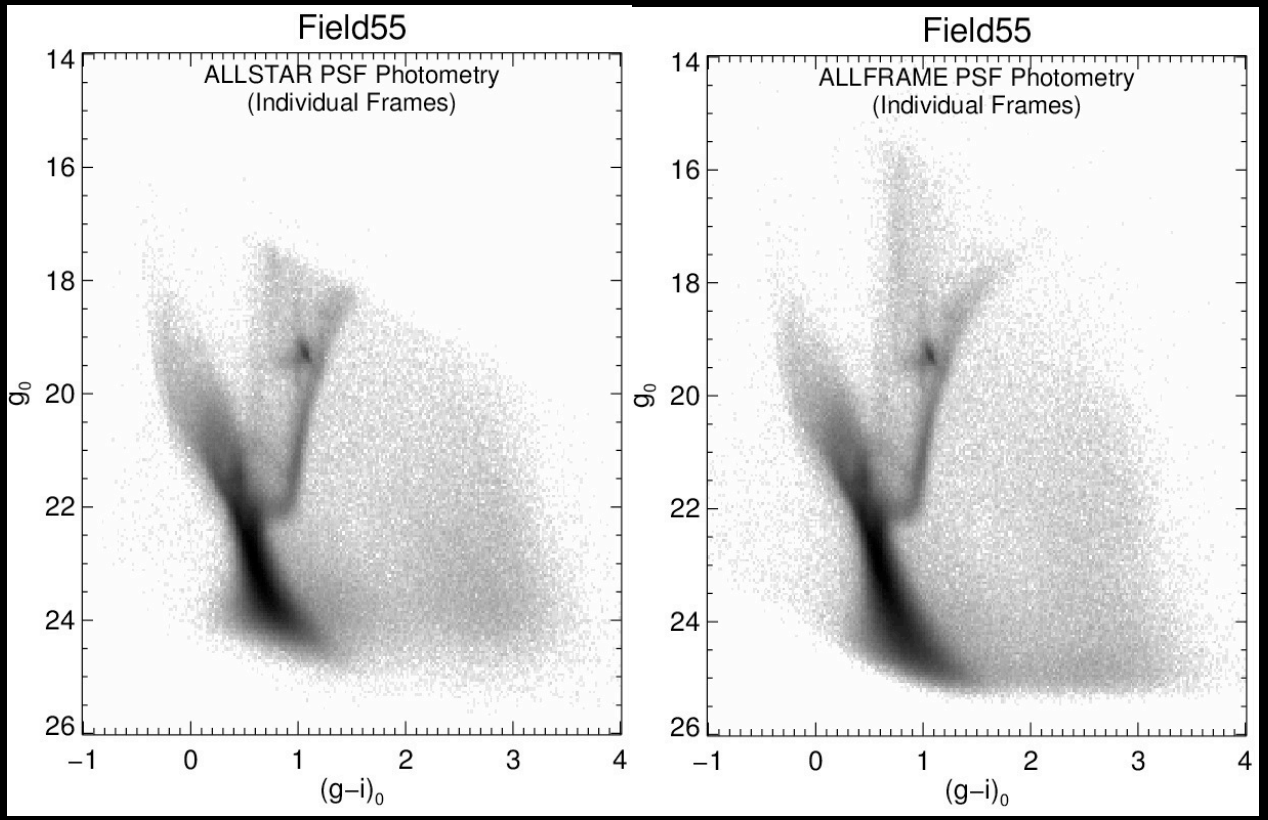
Photometry

Photometry test in Field 55
Process with:

- DESDM
- Nidever's PHOTRED (DAOPHOT-based) on CP products
- Saha's DoPHOT pipeline

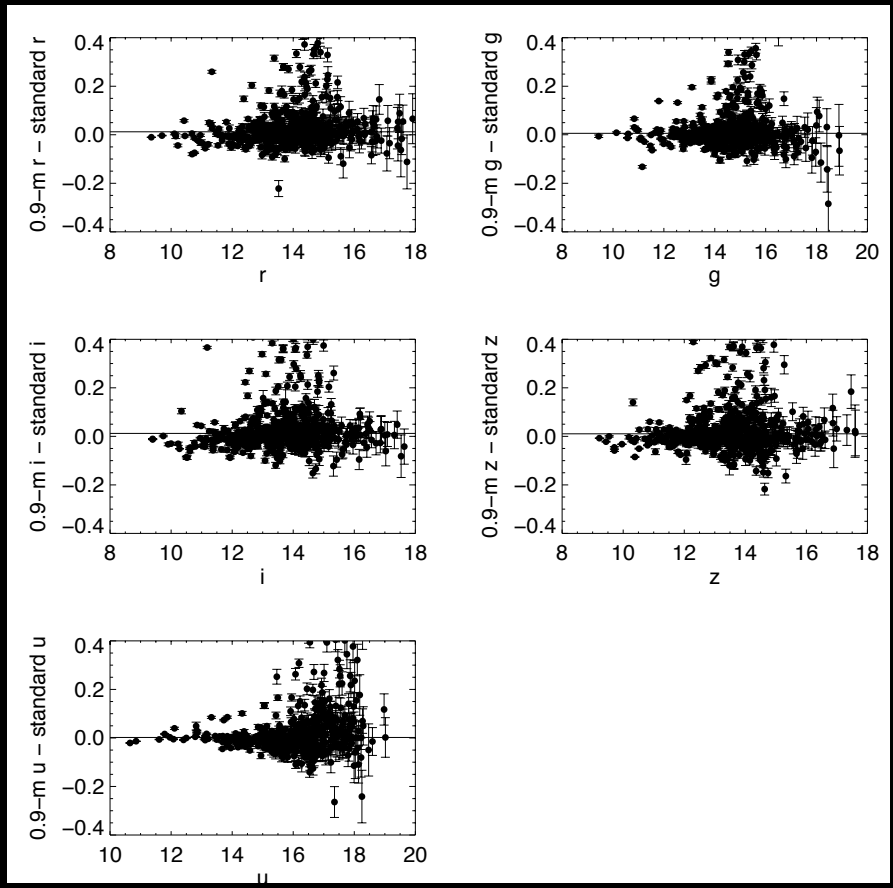
Proceeding with PHOTRED approach

Pipeline for artificial star tests under separate consideration



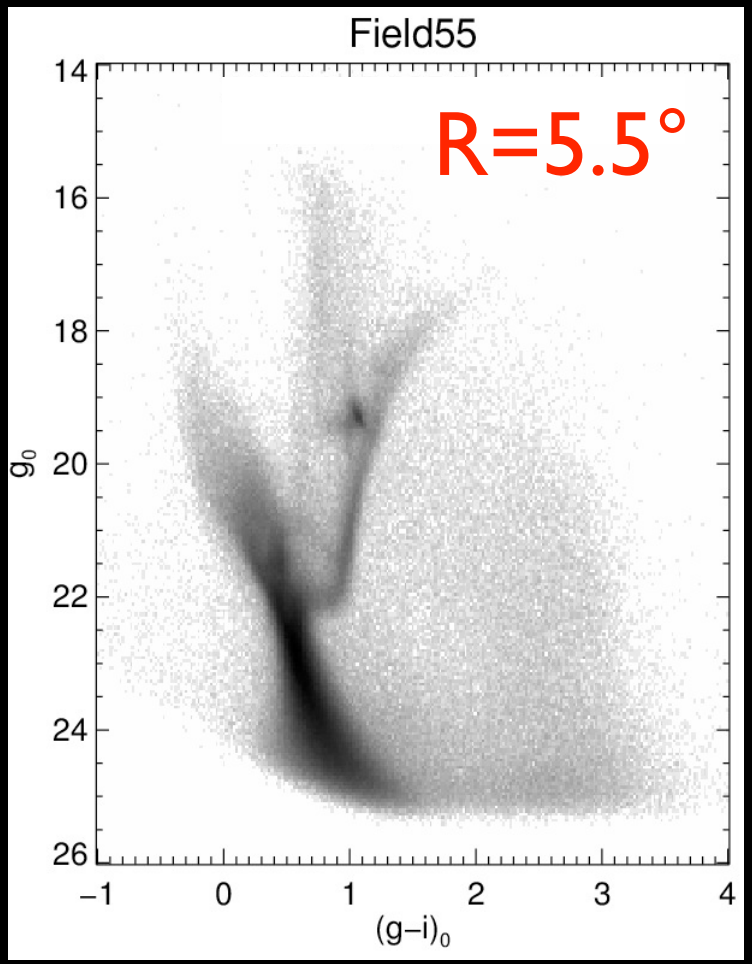
Calibration

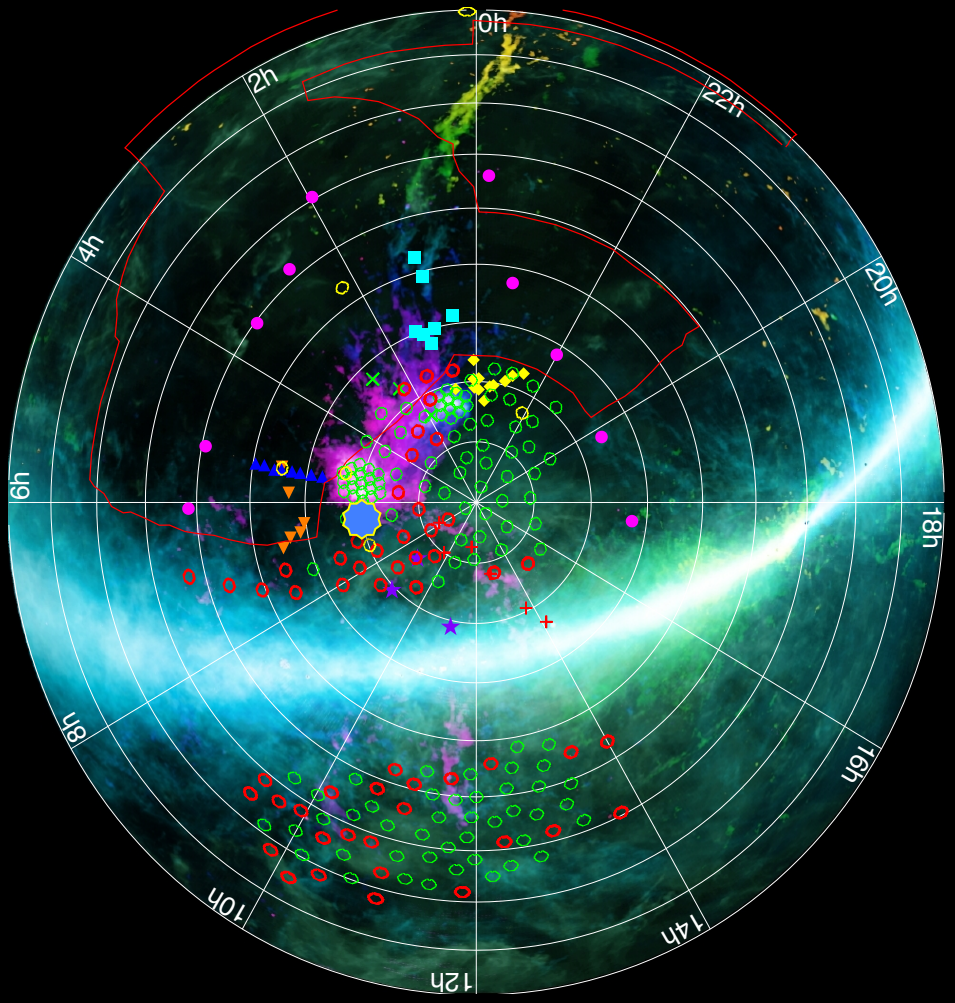
- On photometric 4-m nights, use Smith et al. and Stripe82/Stripe10 standards
- Nidever's STDRED pipeline to solve for transformation equations, including extinction, zero points, and color terms
- Expect to calibrate zero points of 40% of the fields with 0.9-m
- For 0.9-m photometry, fit for extinction, zero point, color term, and linearity
- Transforming to SDSS (will transform to DECam natural system at later date)



Medians all within 0.01 mag of 0.0
Standard deviations ~0.05 mag

Results





Nidever

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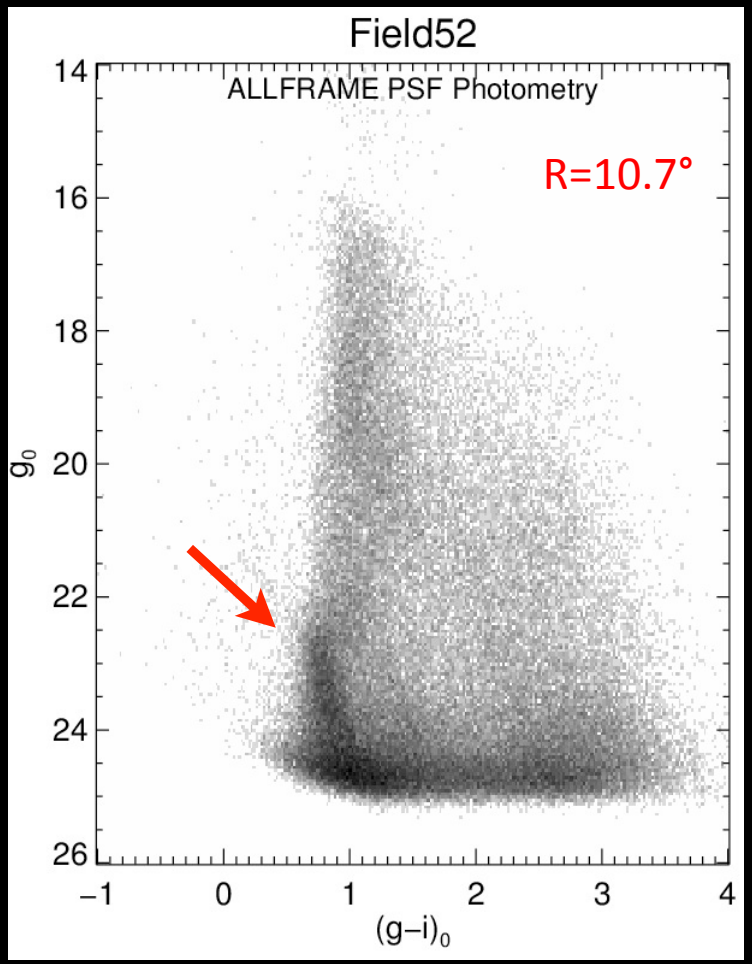

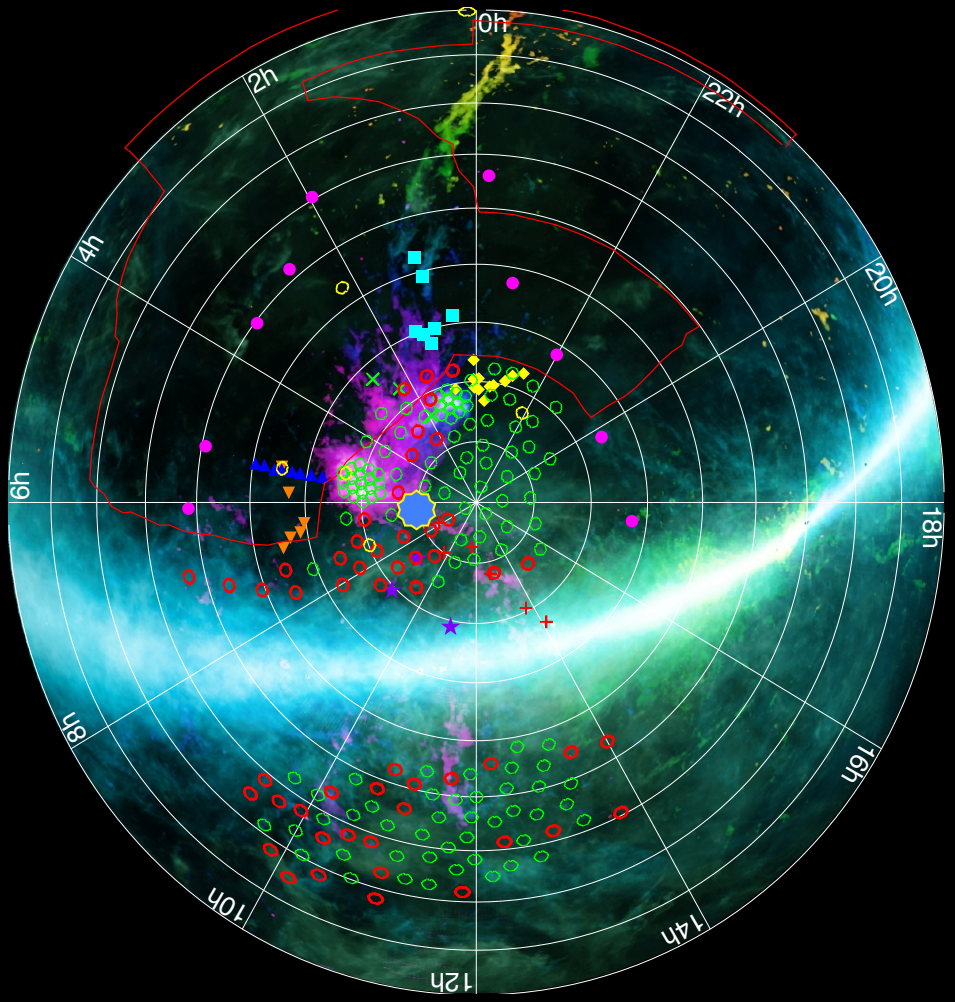

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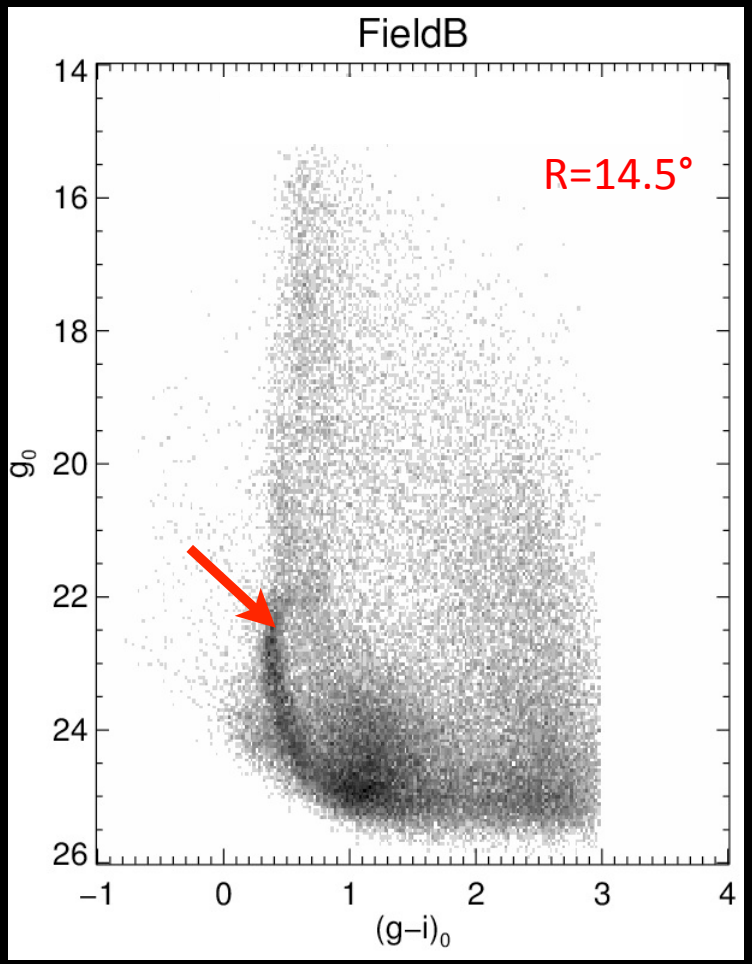

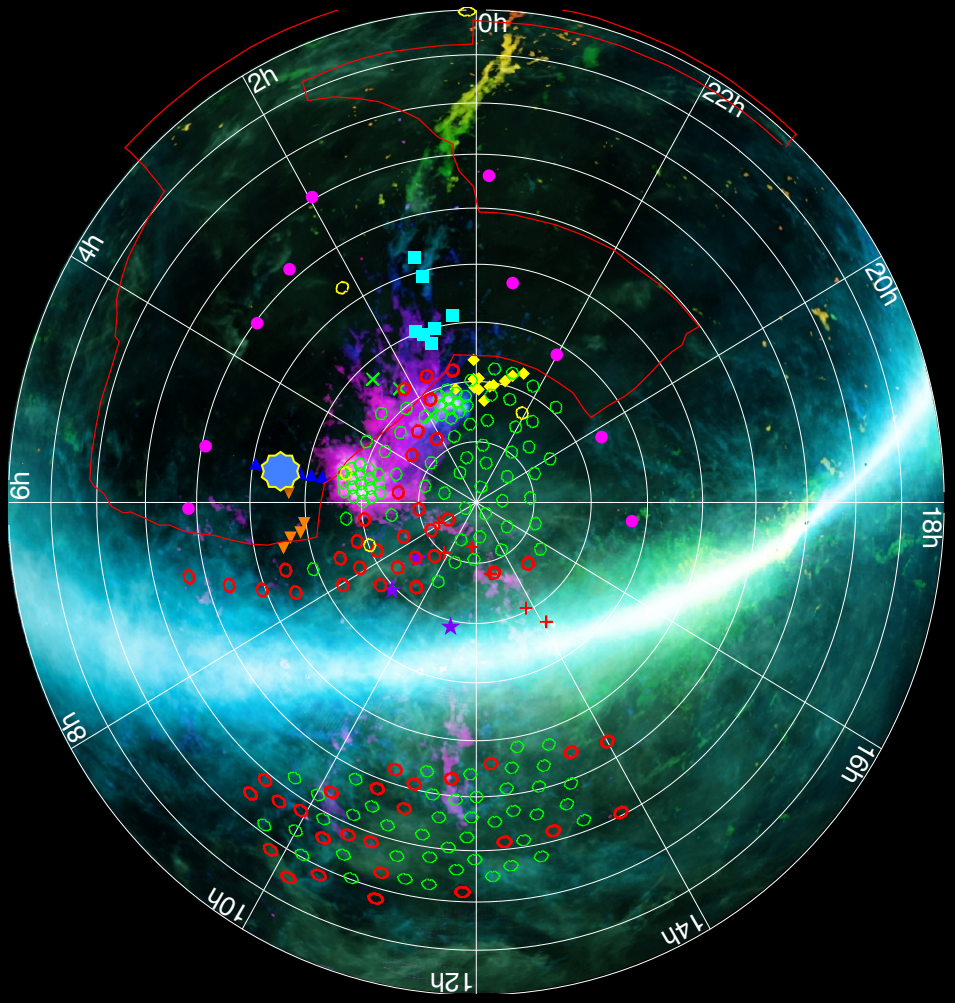

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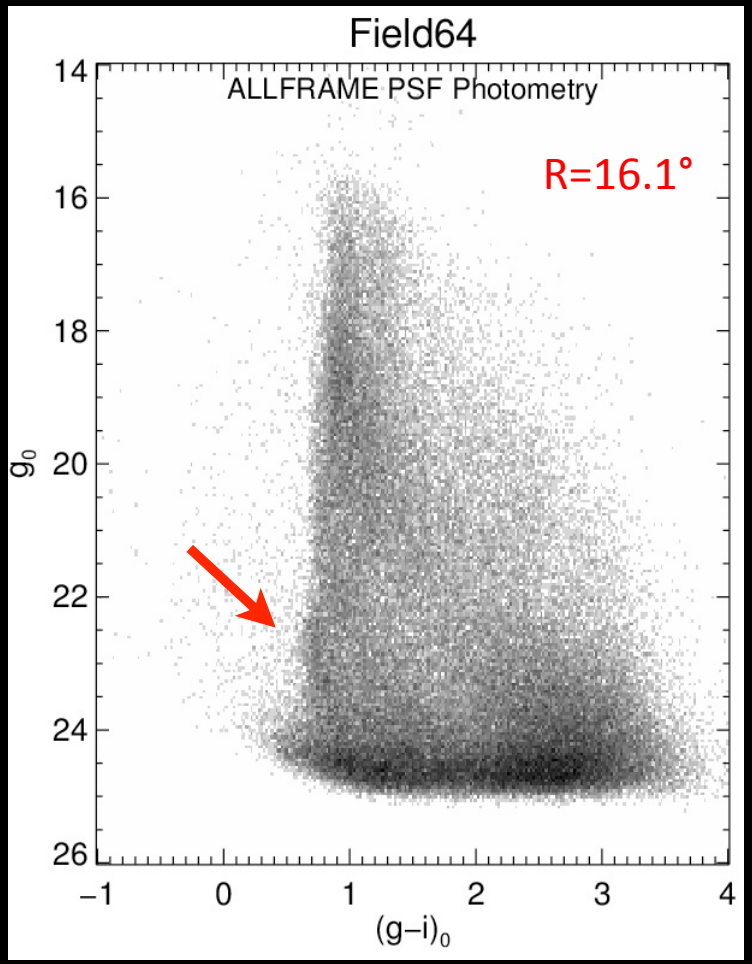

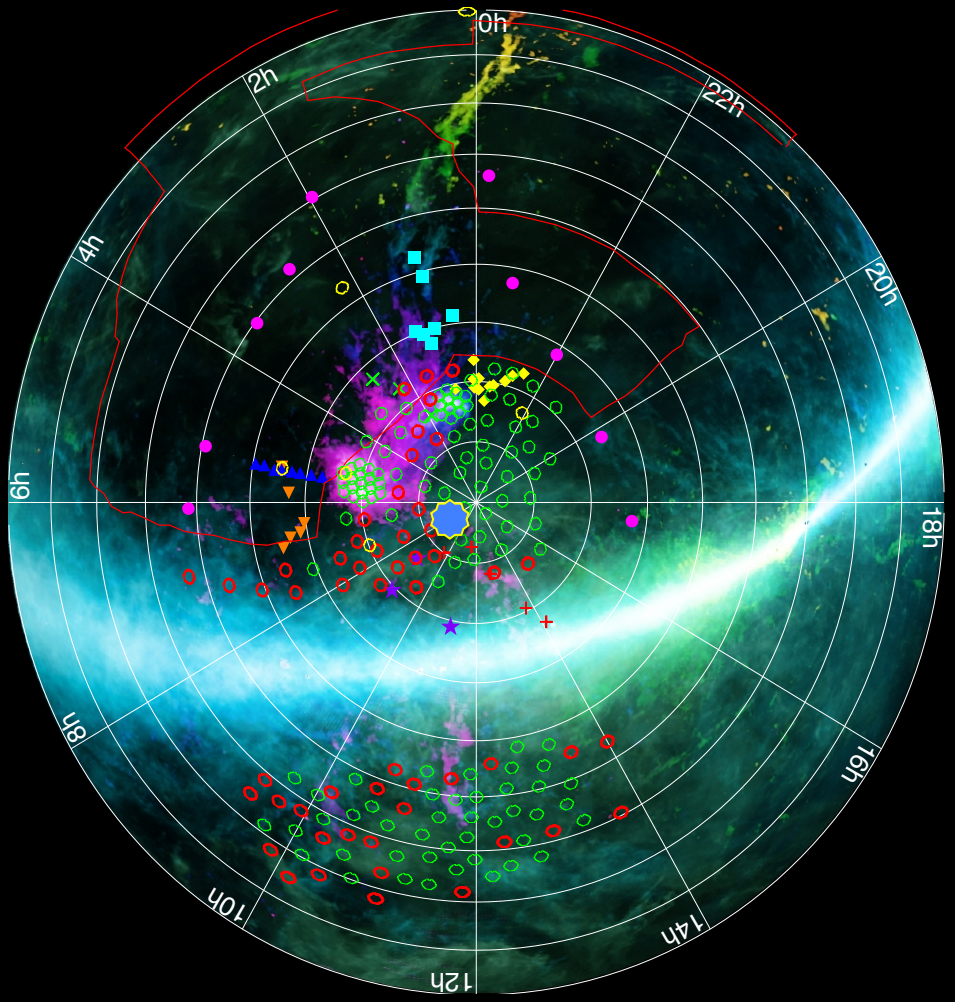

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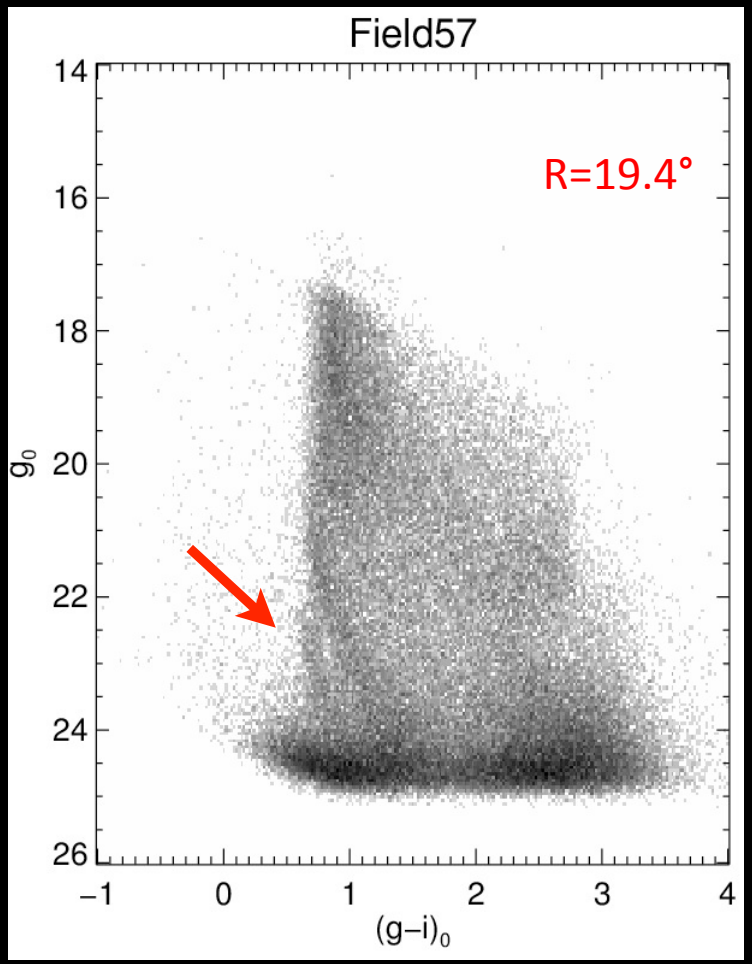

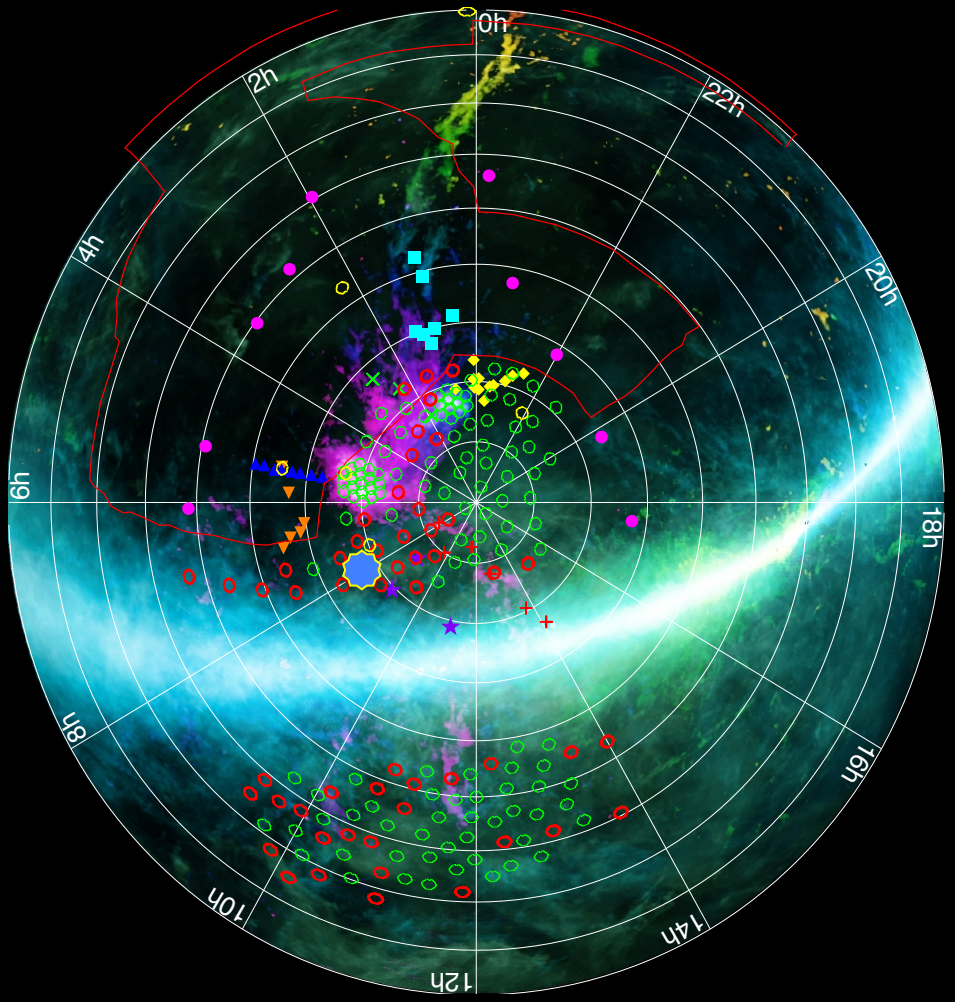

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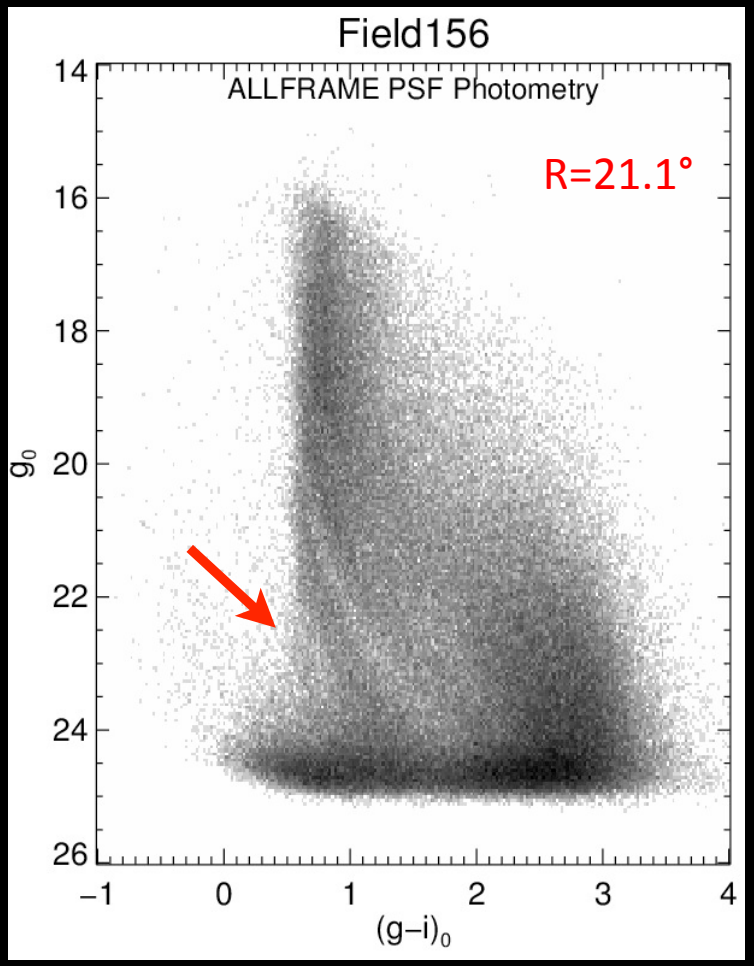

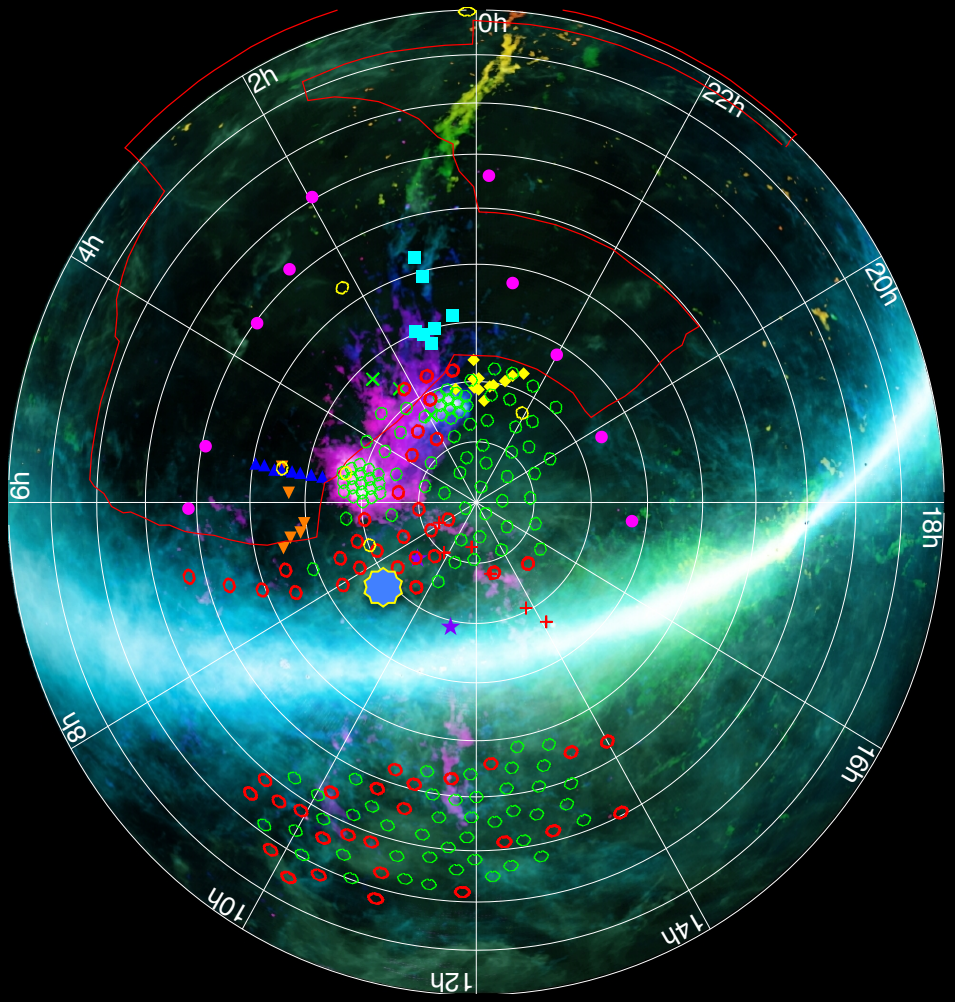

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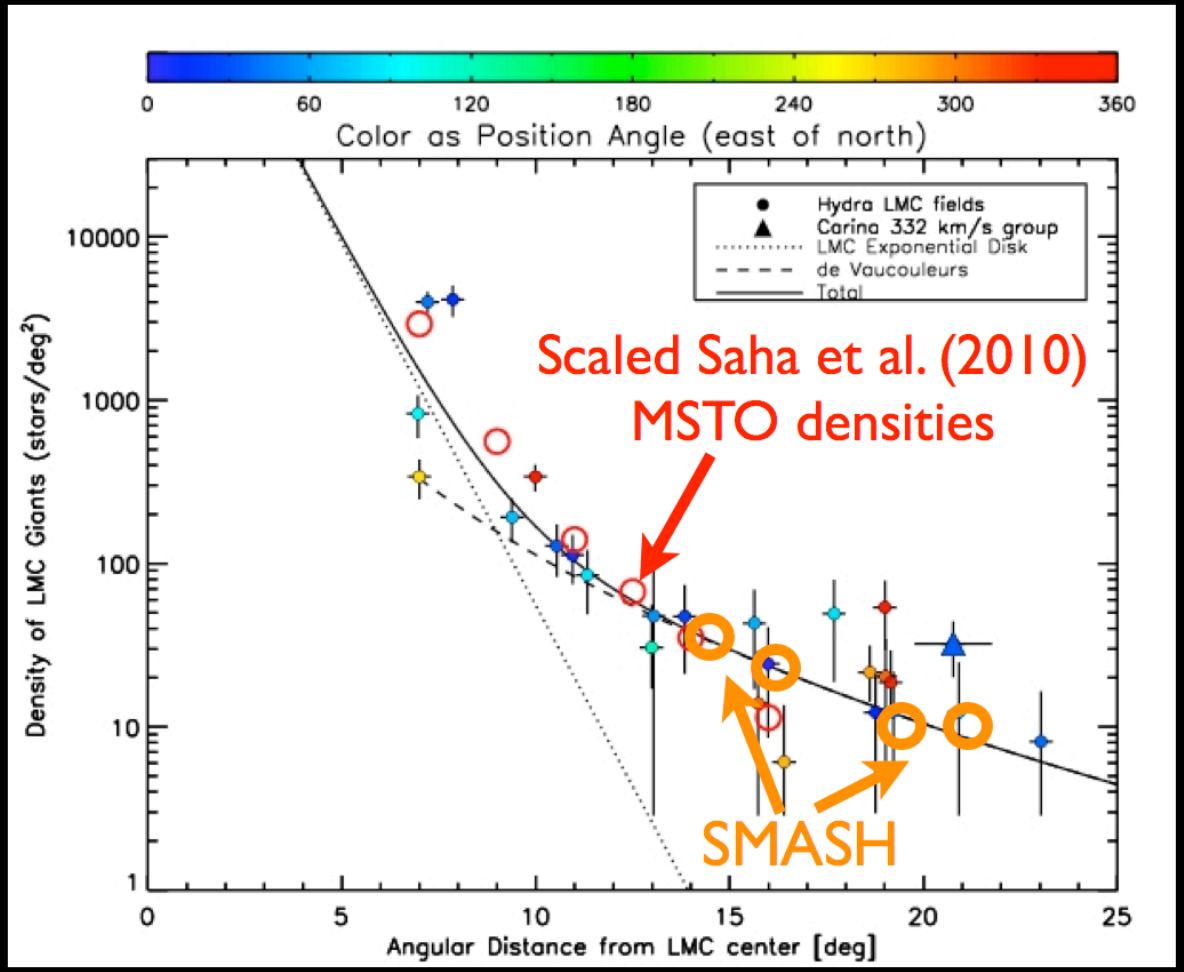

- SMASH LMC densities:
  - R=14.5°, 32.0 mag/arcsec^2
  - R=16.1°, 32.5 mag/arcsec^2
  - R=19.4°, 33.30 mag/arcsec^2
  - R=21.1°, 33.35 mag/arcsec^2
- Very extended LMC
- McMonigal et al. (2014) also detected LMC stars in front of Carina

Nidever

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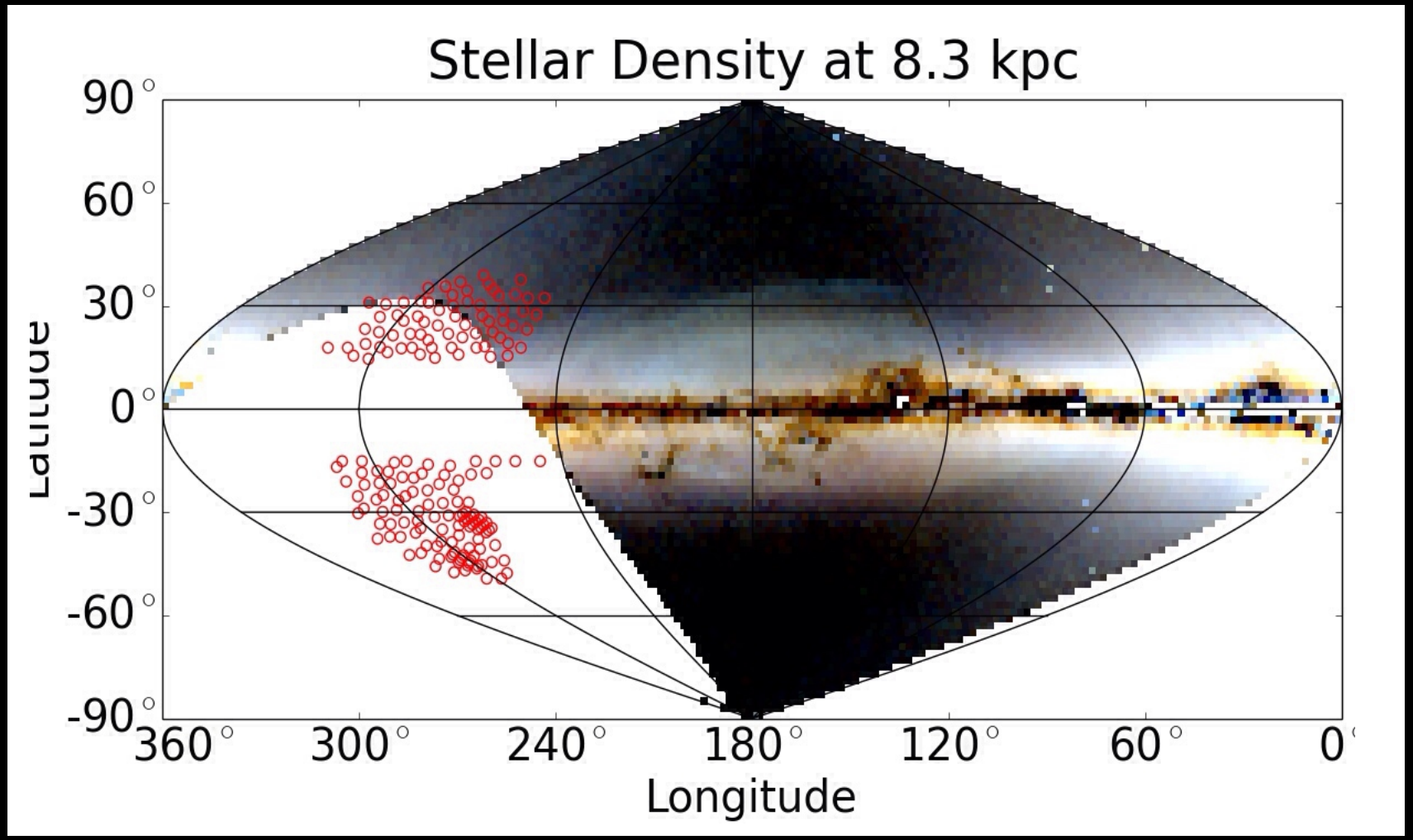
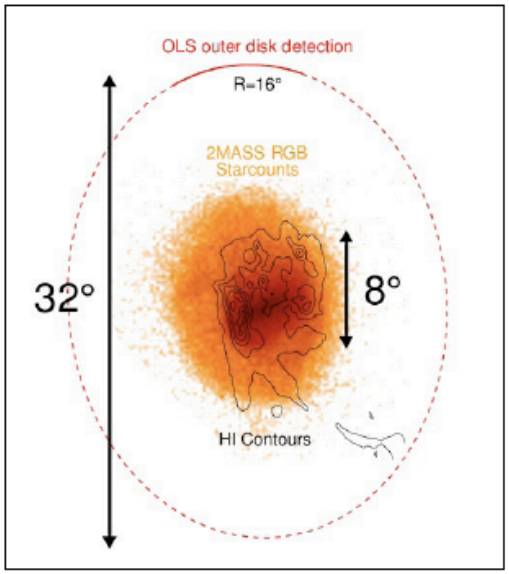
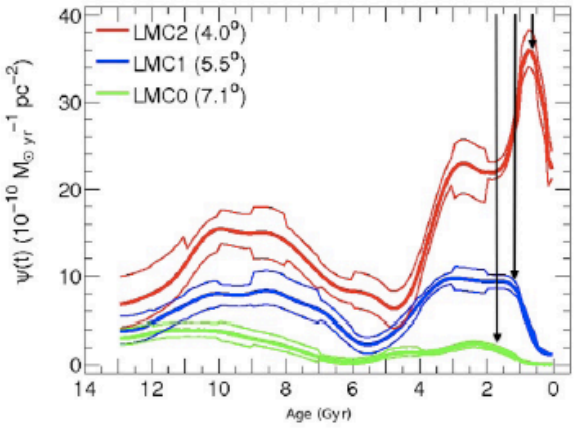


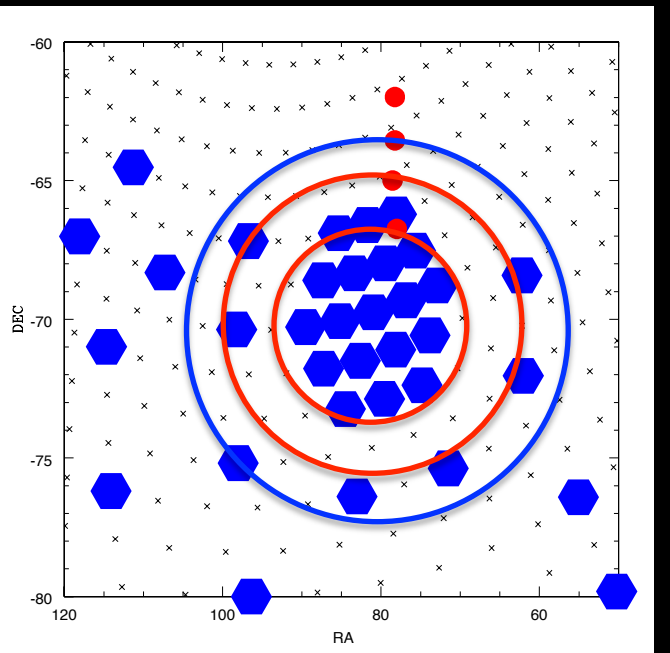
Monoceros ring in SMASH compared to PanSTARRS (courtesy Slater) Vivas and Conn

Plans for Population Analysis

Example goal: Outside-in quenching of the last star forming event related to ram pressure stripping or stellar gas consumption and/or feedback

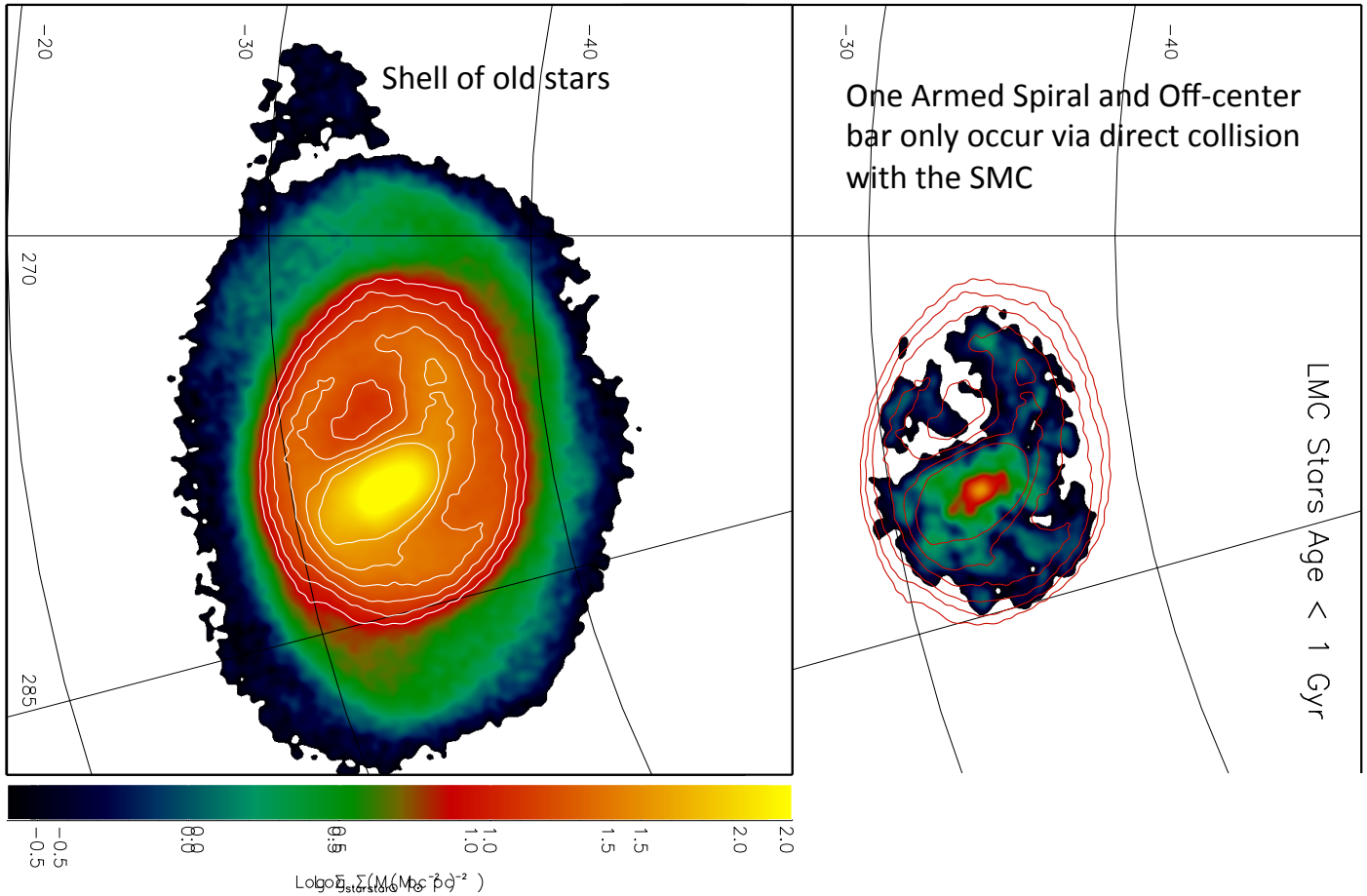






Gallart and Monelli

Results: Modeling

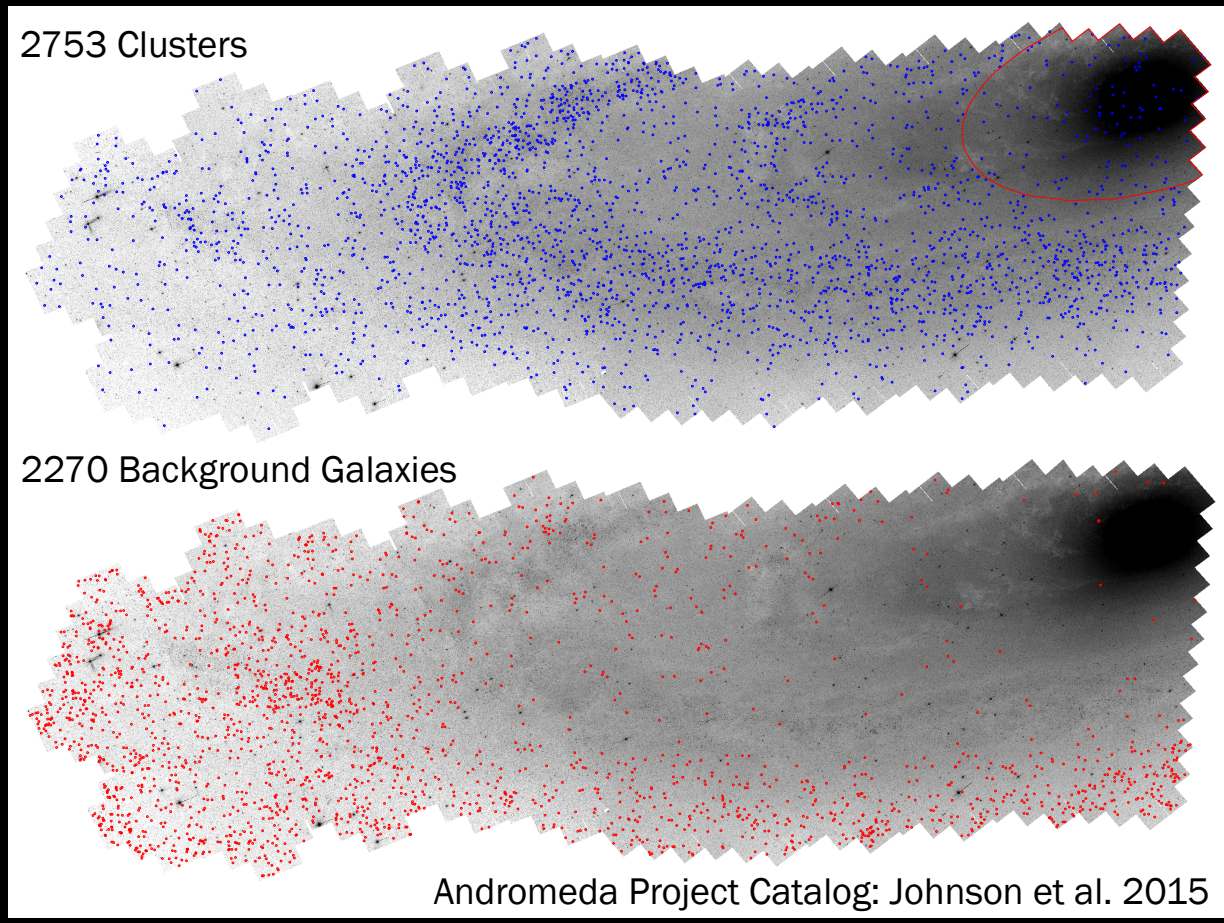


Besla, Martinez-Delgado, Schiminovich, Seibert, van der Marel et al. In prep

Besla

Plans for Star Clusters

- Andromeda Project led by Ciff Johnson as part of PHAT survey of M31 (PI Dalcanton)
- Yielded uniform catalog of star clusters as well as completeness computed from simulated clusters
- Magellanic Clouds Project would be 5× Andromeda Project
- Provide basis for cluster formation efficiency



Andromeda Project Catalog: Johnson et al. 2015

Conclusion

- Our understanding of the Magellanic Clouds as a system is rapidly changing
- Wide-ranging consequences, e.g. for:
  - Galaxy interactions
  - Star formation
  - Distance scale
  - Galactic halo
- Stay tuned for SMASH results!