RADIAL PROFILES OF *STAR FORMATION HISTORIES* IN LOCAL DWARFS AND THE MAGELLANIC CLOUDS

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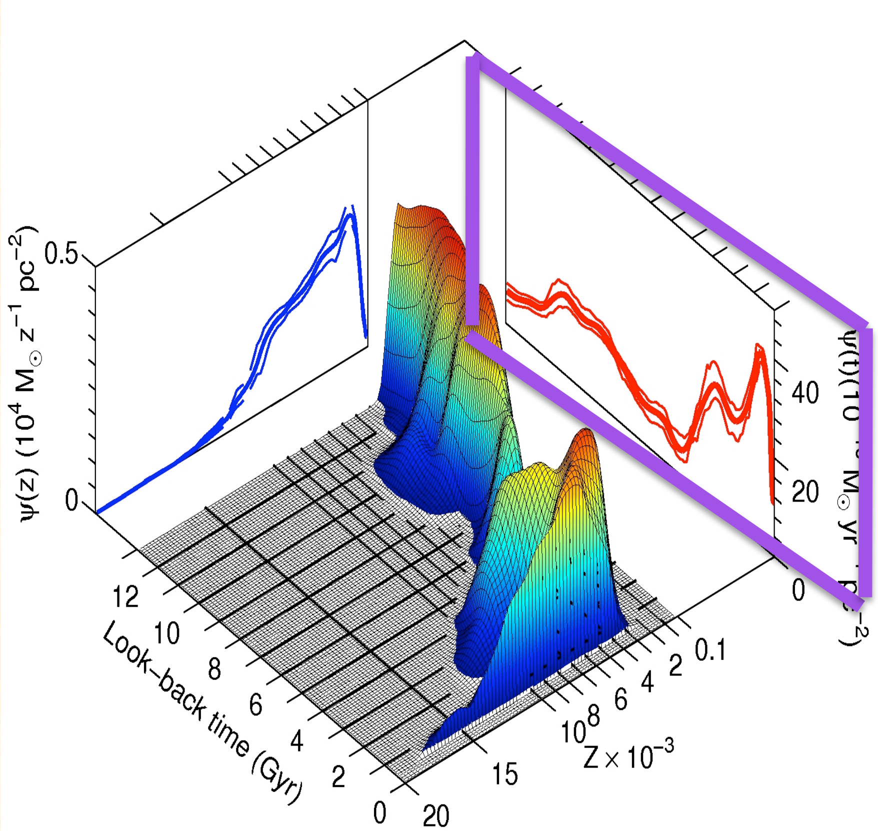
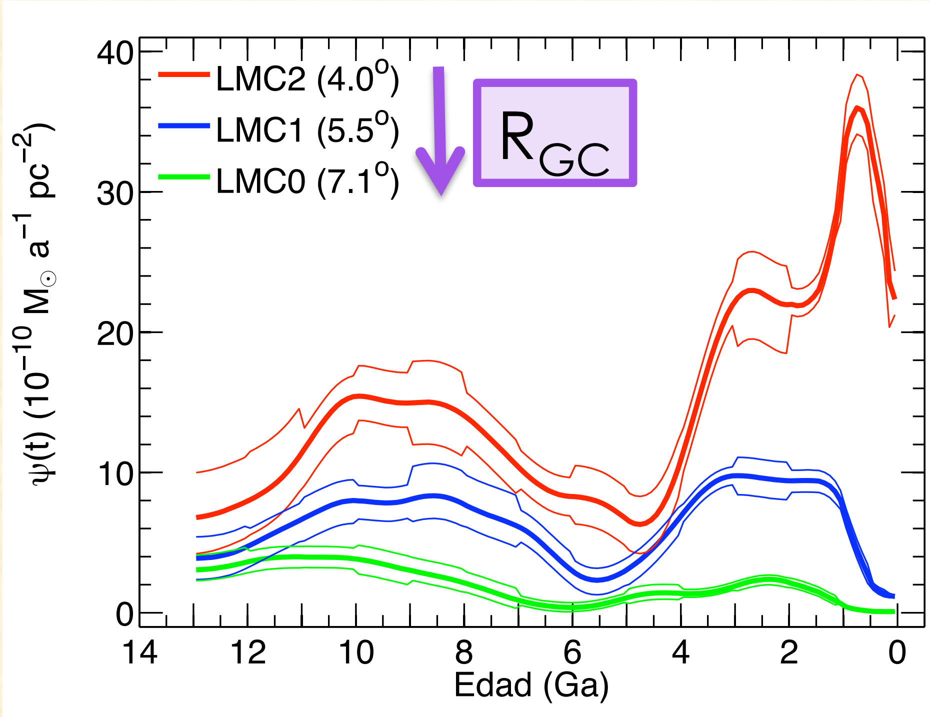


STAR FORMATION HISTORY: Star formation rate as a function of time and metallicity, $\Psi(t,z)$, obtained at different R_{GC}



Trace the structural evolution of the galaxy.

Provide hints on mechanisms shaping dwarf galaxy evolution.

Radial variation of stellar populations in dIrr galaxies: “Baade´s Sheet“

VII. ANGULAR EXTENT OF THE GALAXY

Baade took a series of deep red plates to search for the extent of the background sheet of Population II stars, which begins suddenly to resolve into stars at $V \simeq 21.5$. The series of 200-inch plates was centered to map the boundary on the East, South, and West sides adequately, as marked on the reproduction from a blue 48-inch Schmidt plate shown in Figure 15 (Plate 9).

The limiting boundary is roughly elliptical, with major and minor axes of 25′.07 and 20′.27, respectively, at a position angle of about 90°. The linear dimensions are 5600 by 450 pc, which represent the extreme size to which the oldest stars can be traced. Figure 15 shows that the prominent Population I component is confined well within these boundaries by about a factor of 2. IC 1613 is an exceedingly small galaxy.

Sandage (1971, ApJ)

“Baade took a series of deep red plates to search for the extent of the background sheet of Population II stars… The limiting boundary is roughly elliptical, with major and minor axis of 25´ and 20’ respectively (…). Figure 15 shows that the prominent Population I component is confined well within these boundaries by about a factor of 2”

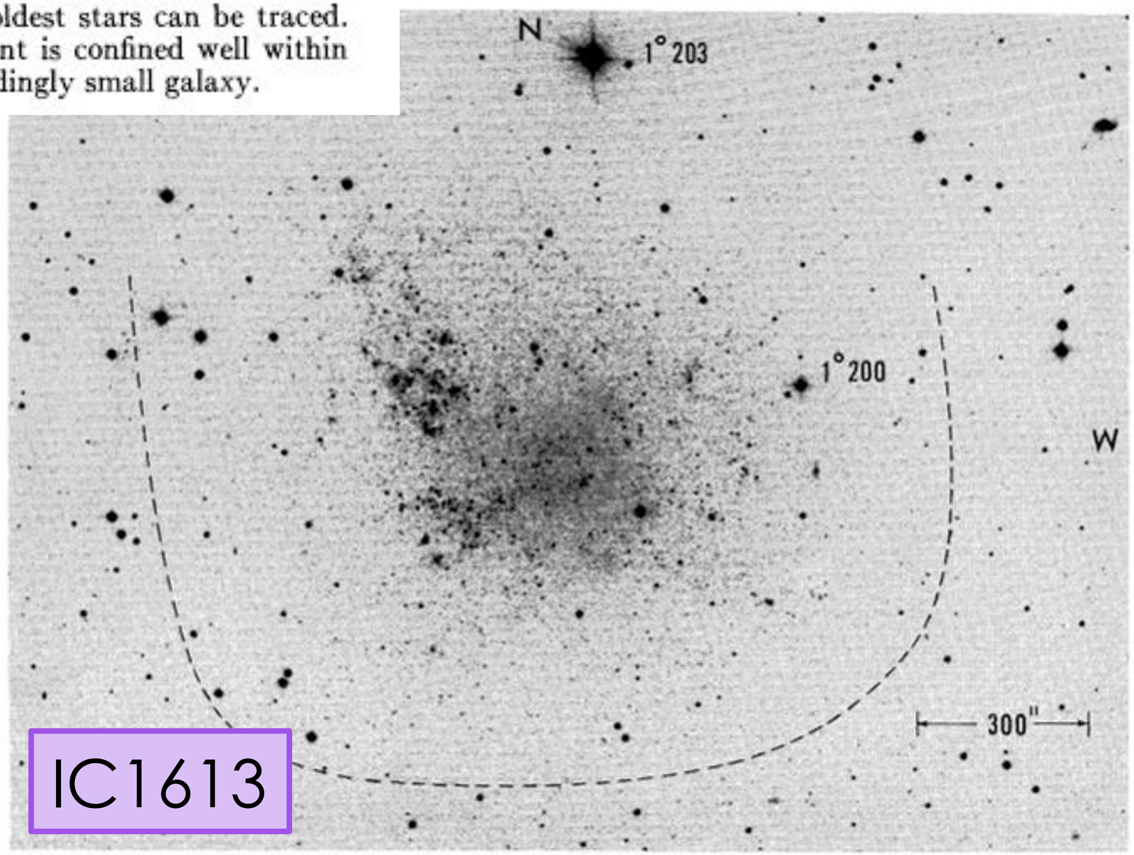
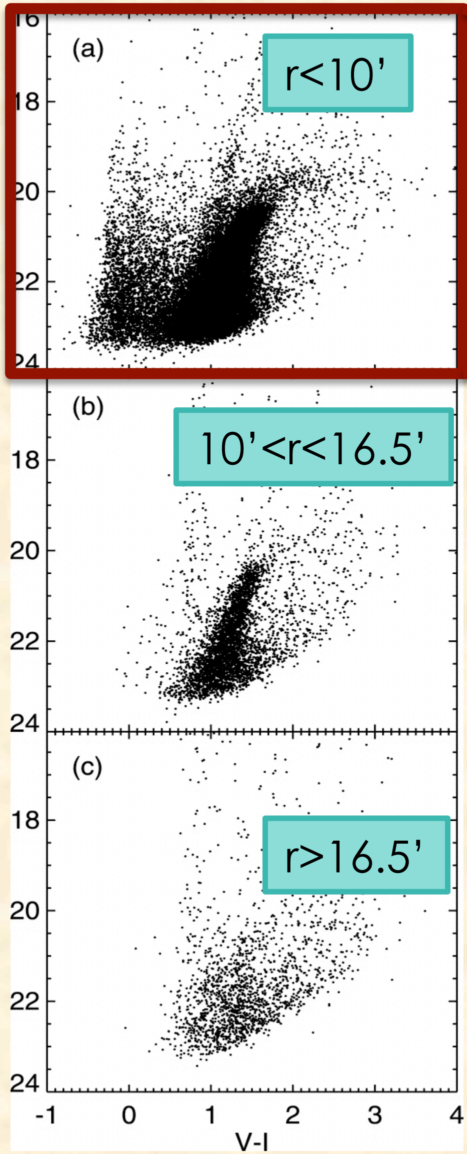
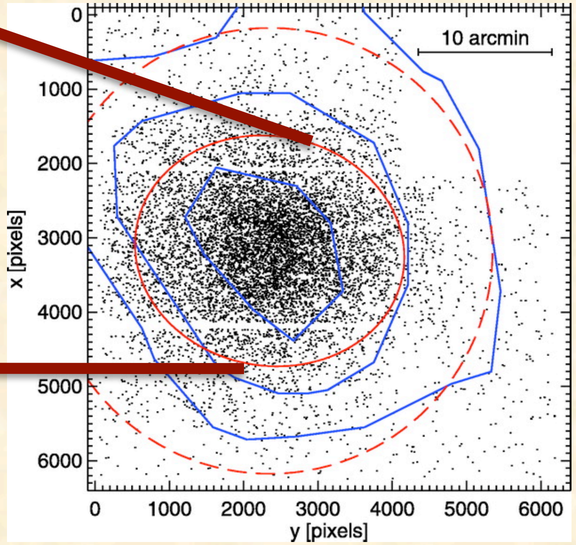


FIG. 15.—Enlarged copy of the blue plate of IC 1613 from the *Palomar Sky Survey*. The extent of the Population II component of the galaxy is marked as found from red 200-inch plates taken of the E, S, and W sectors.

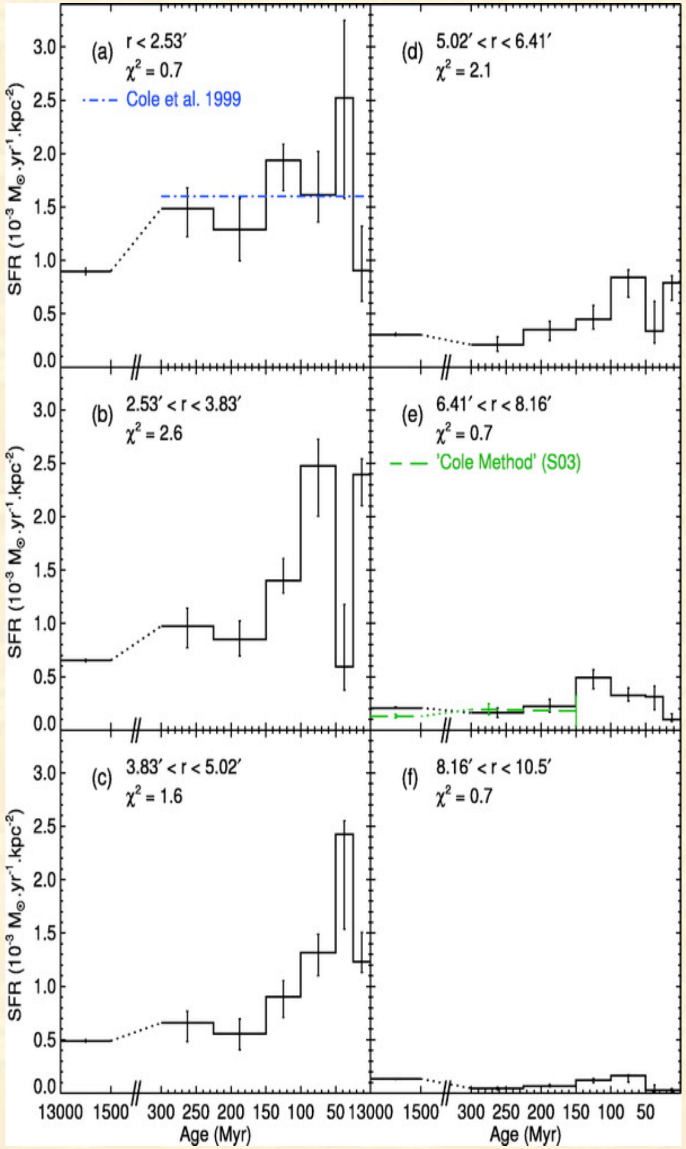
SANDAGE (*see* page 32)

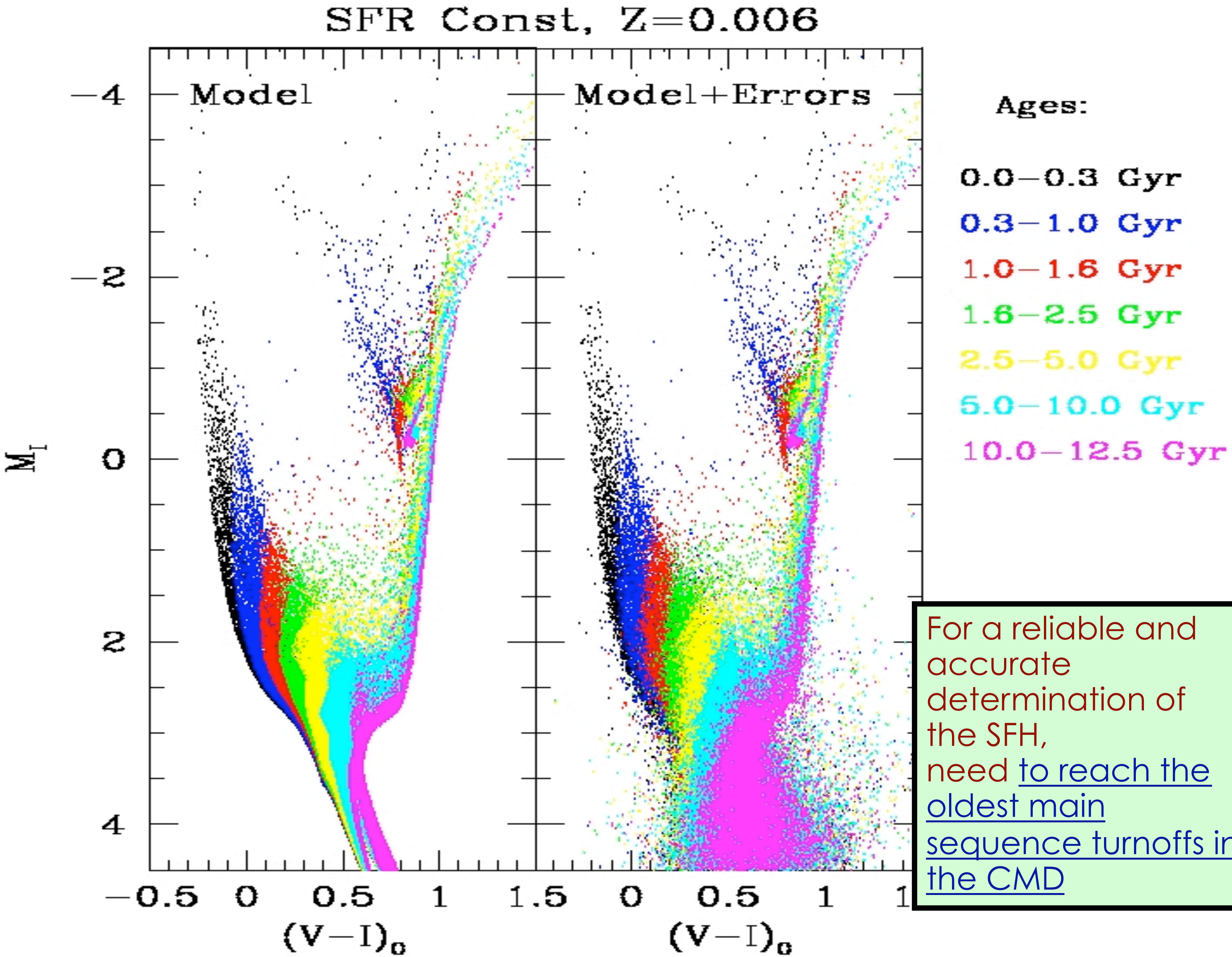
Modern ground-based characterization of “Baade´s Sheet”



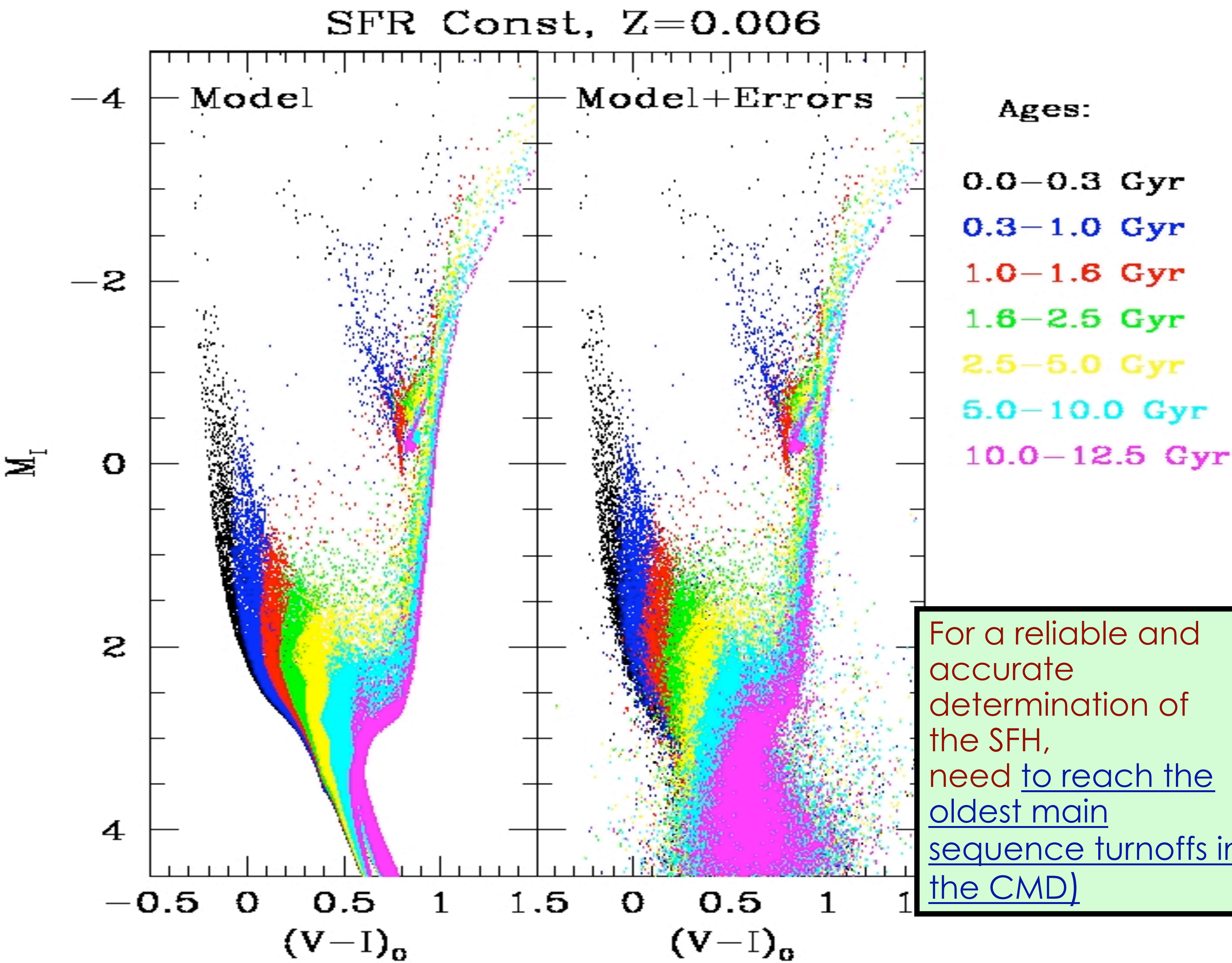


IC1613 dIrr @≈0.7Kpc
Bernard et al. 2007



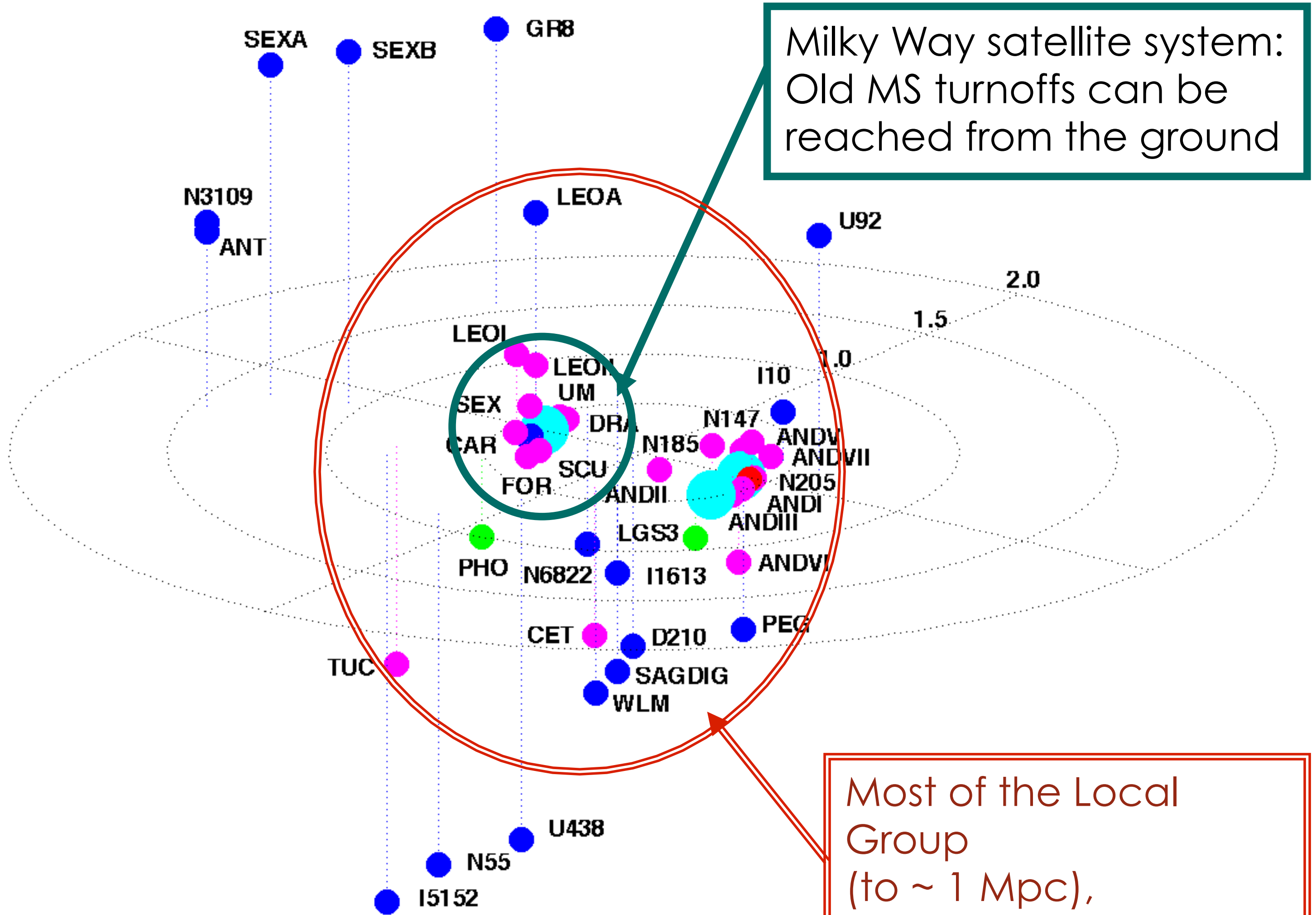


For a reliable and accurate determination of the SFH, need to reach the oldest main sequence turnoffs in the CMD



For a reliable and accurate determination of the SFH, need to reach the oldest main sequence turnoffs in the CMD)

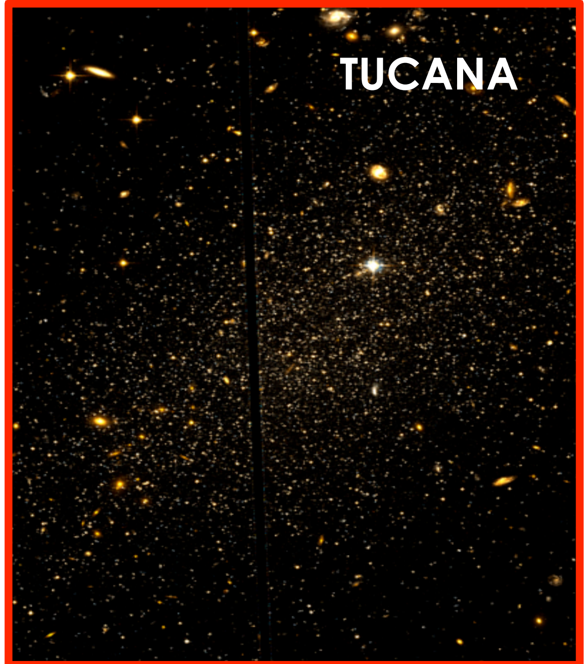
THE LOCAL GROUP

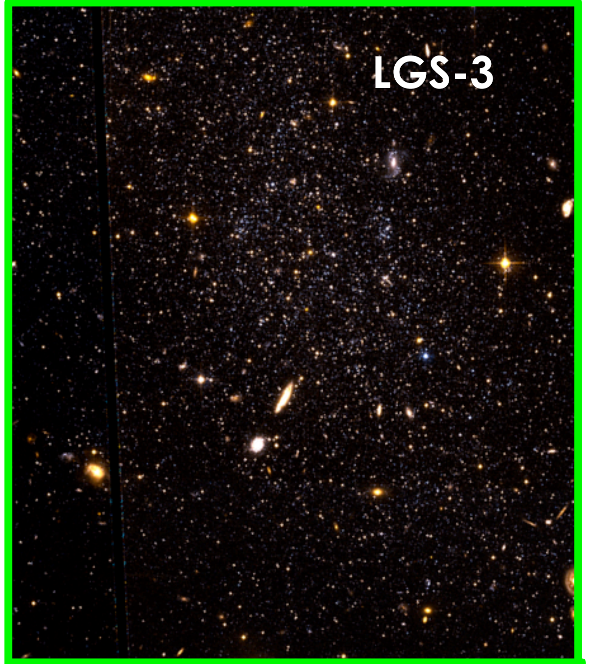


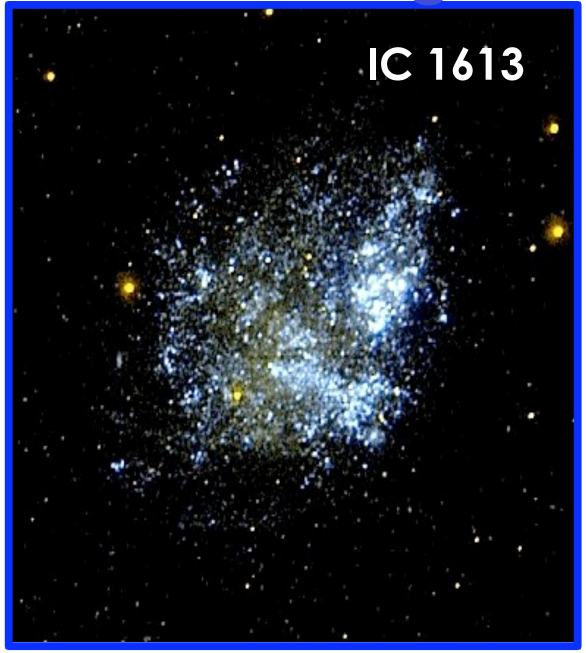
Milky Way satellite system: Old MS turnoffs can be reached from the ground

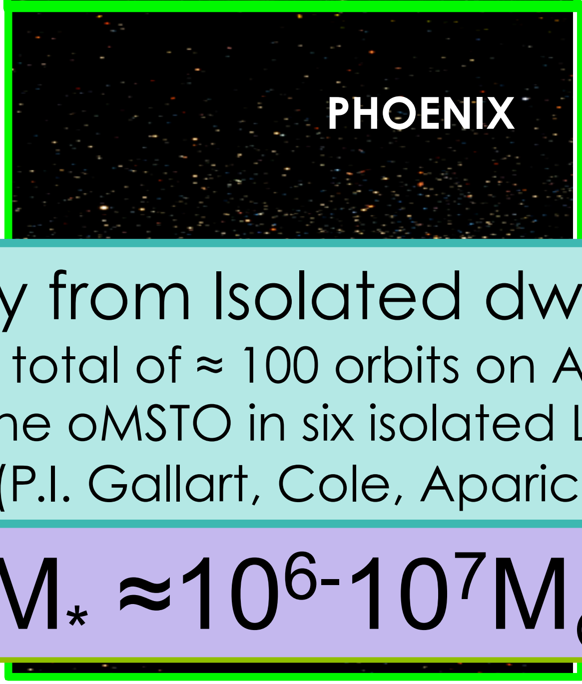
Most of the Local Group (to ~ 1 Mpc), with ACS on HST

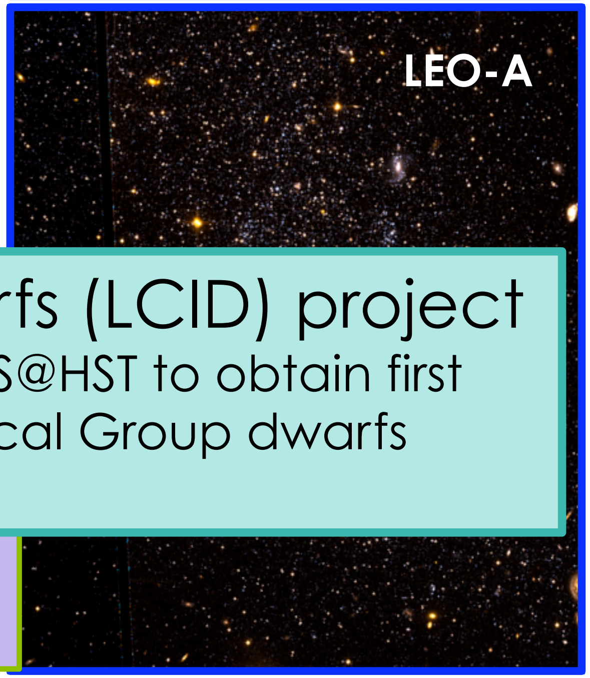
Dwarf Spheroidals | Transition dSph/dIrr | Dwarf Irregulars









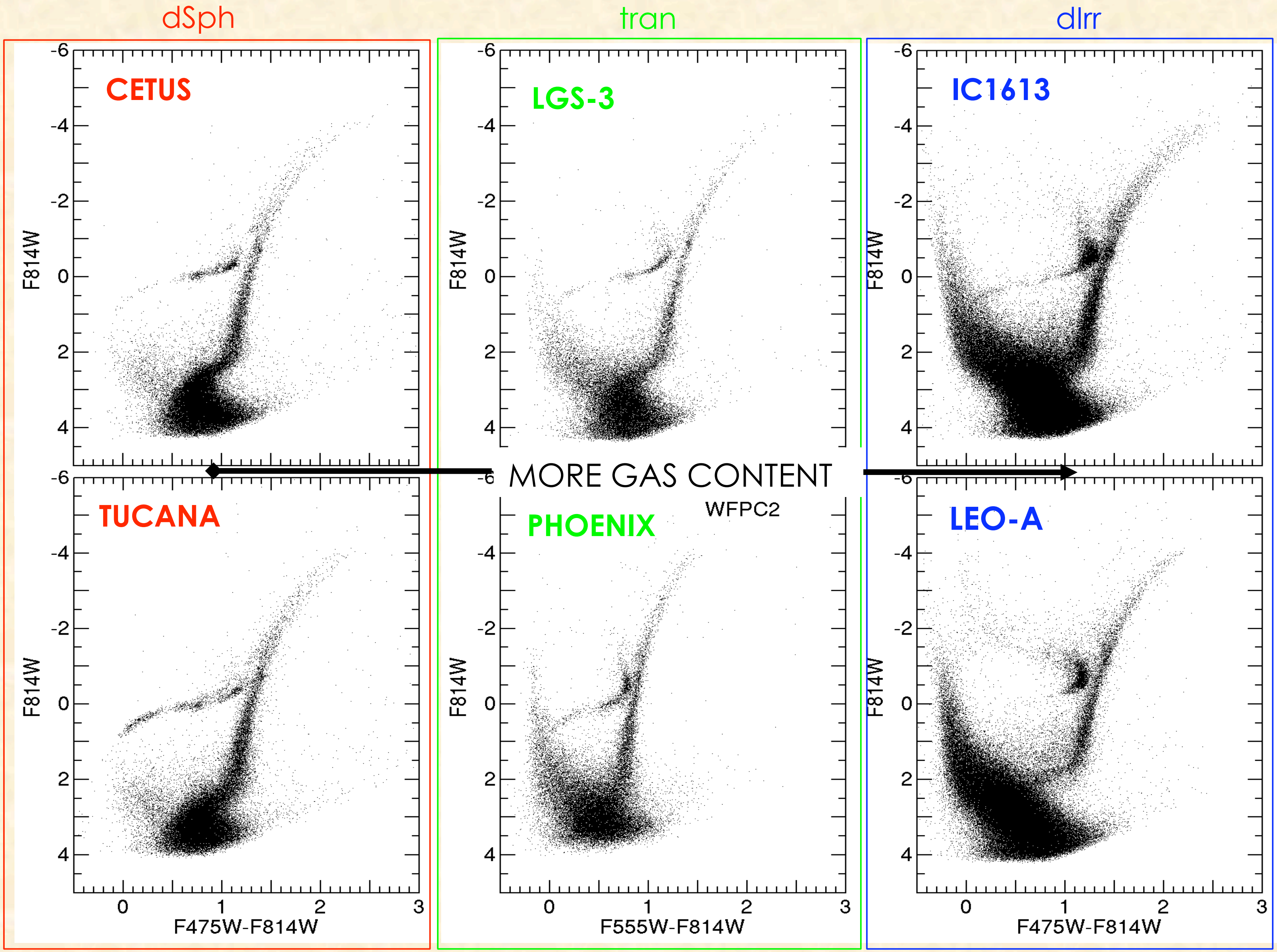


Local Cosmology from Isolated dwarfs (LCID) project

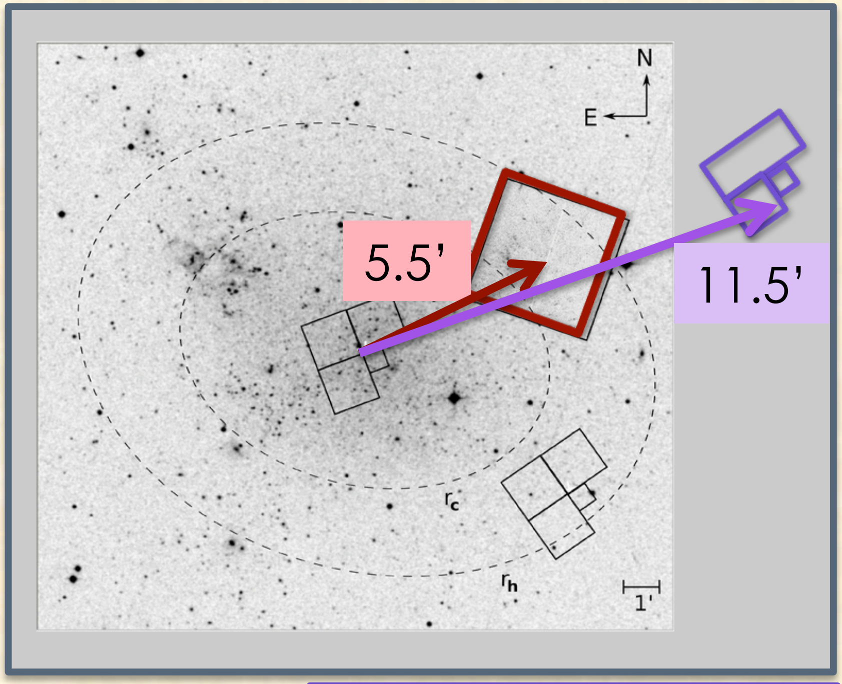
3 HST projects for a total of ≈ 100 orbits on ACS@HST to obtain first CMDs reaching the oMSTO in six isolated Local Group dwarfs (P.I. Gallart, Cole, Aparicio)

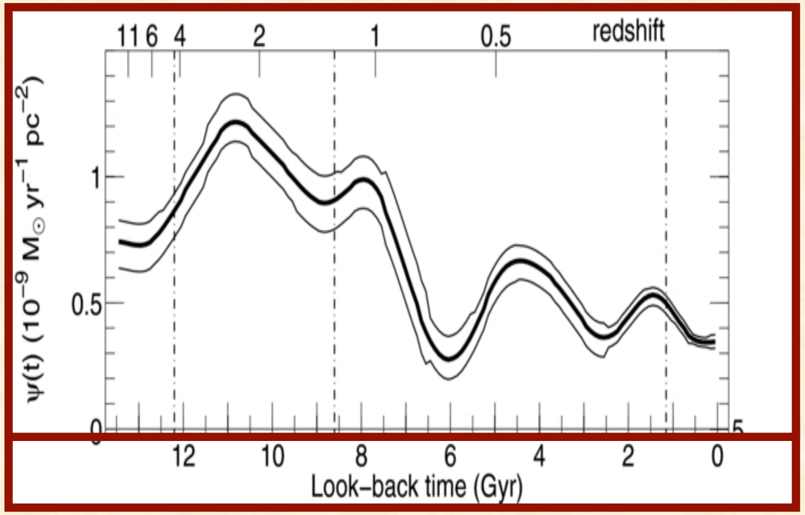
$M_* \approx 10^6 - 10^7 M_\odot$

LCID CMDs sample



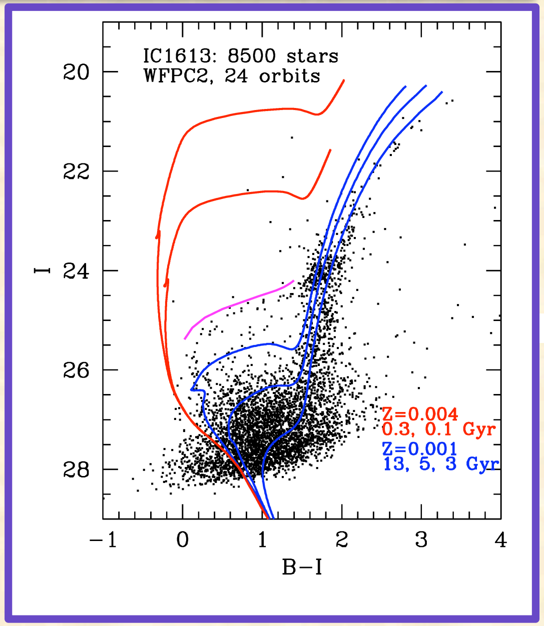
Baade's sheet as revealed by HST: IC1613

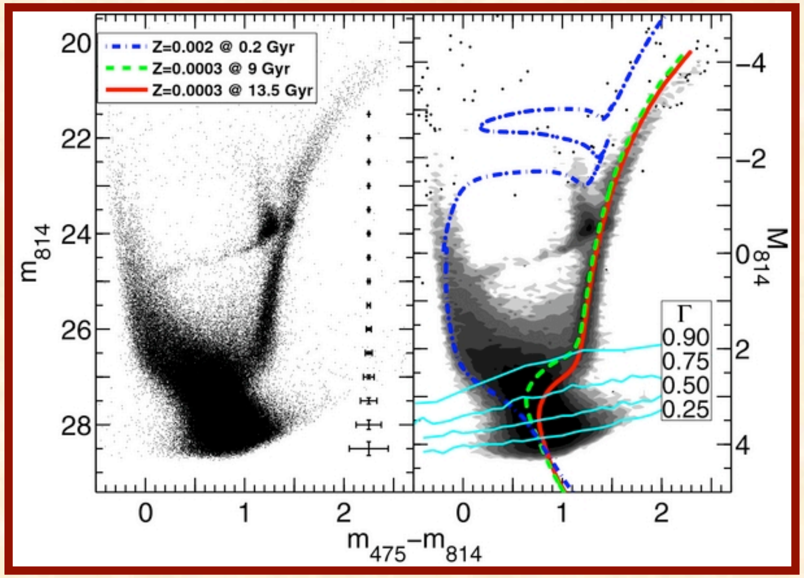




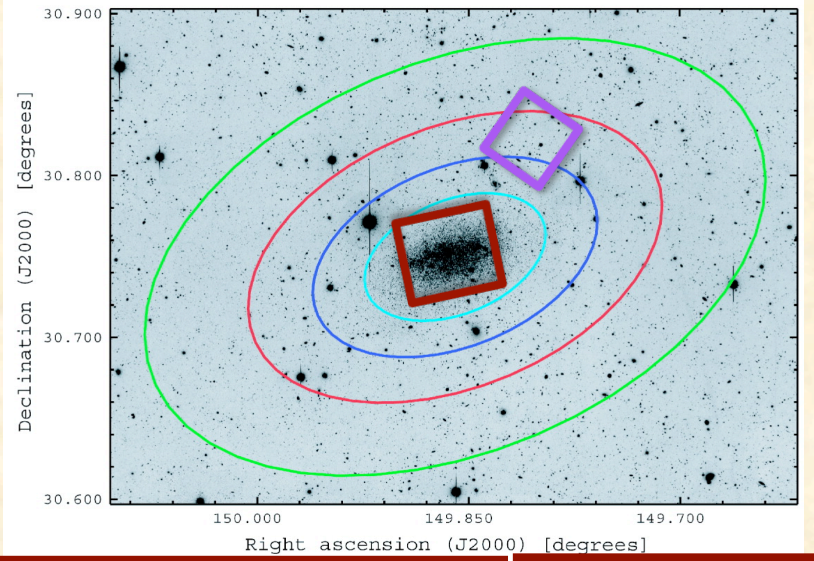
Skillman+LCID 2013, ApJ

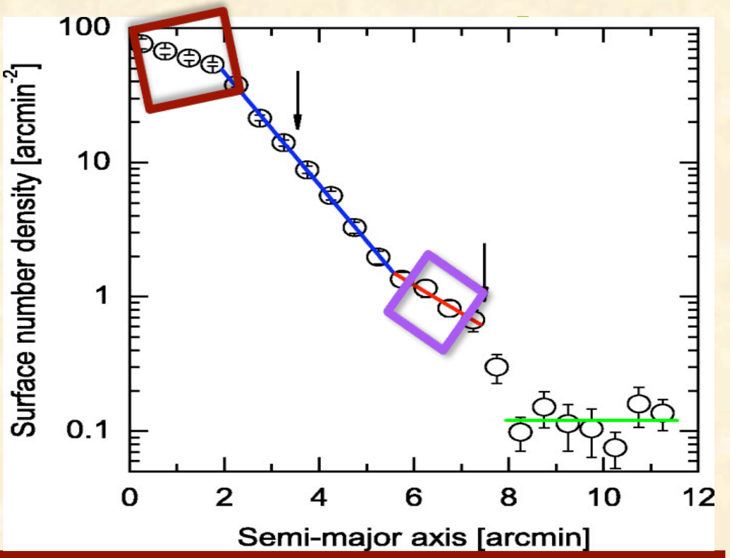
Not a purely old "stellar halo"

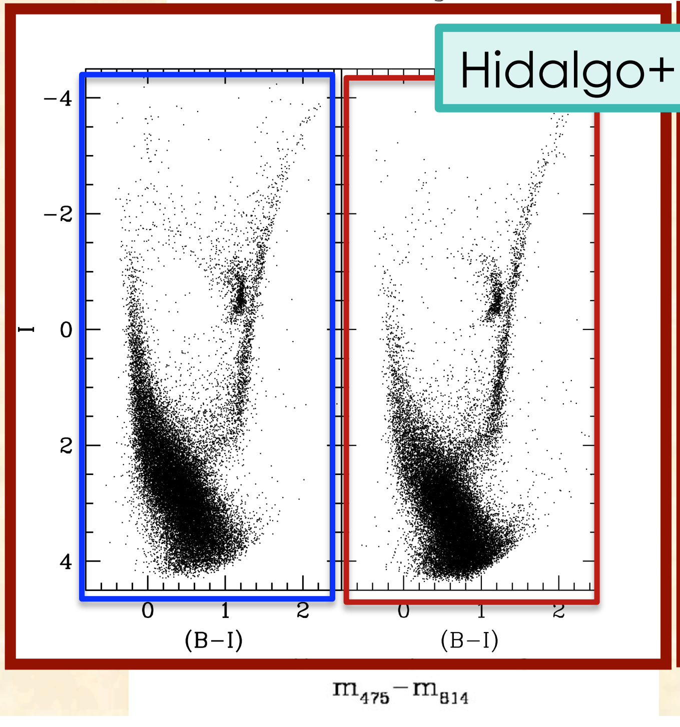




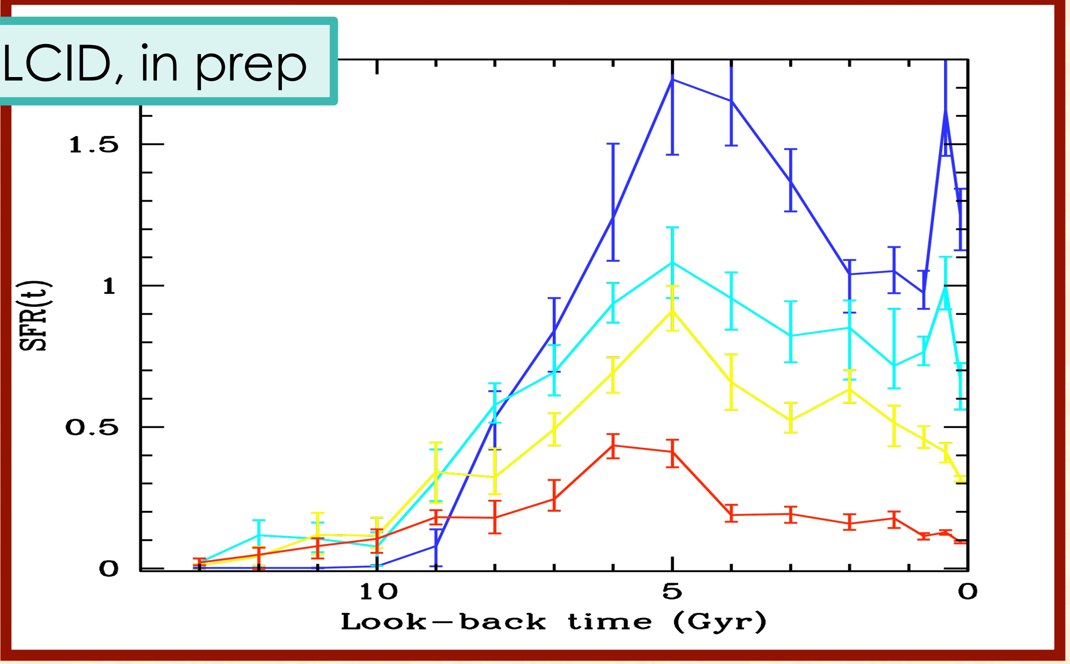
Radial variations in the SFH of Leo A



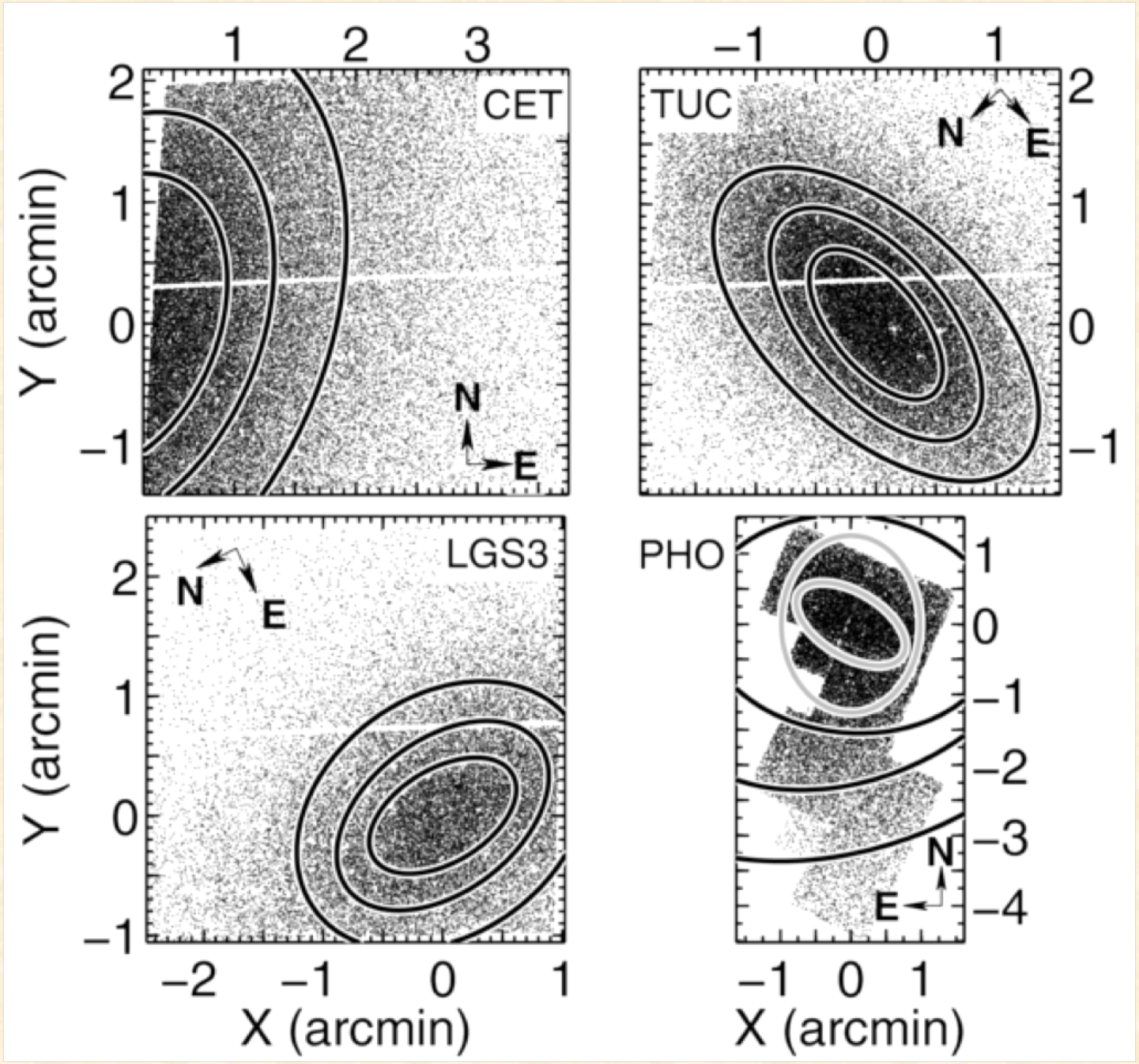




Hidalgo+LCID, in prep

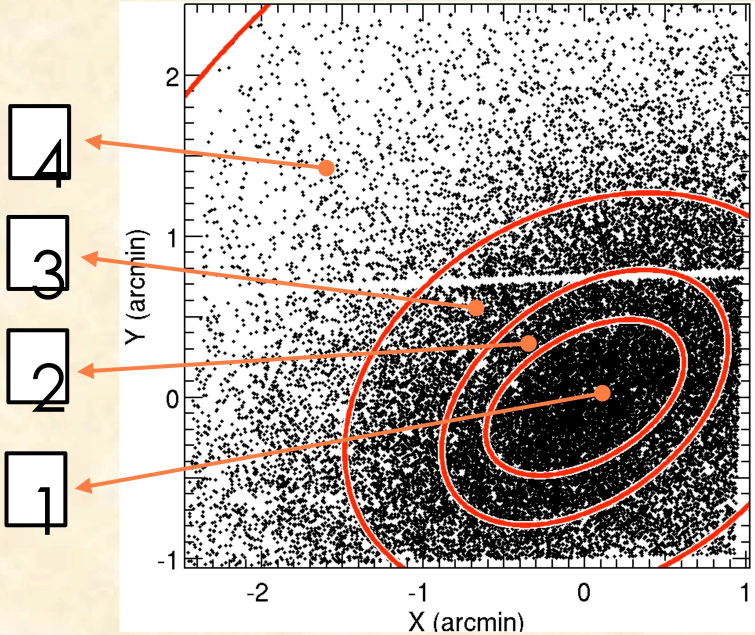


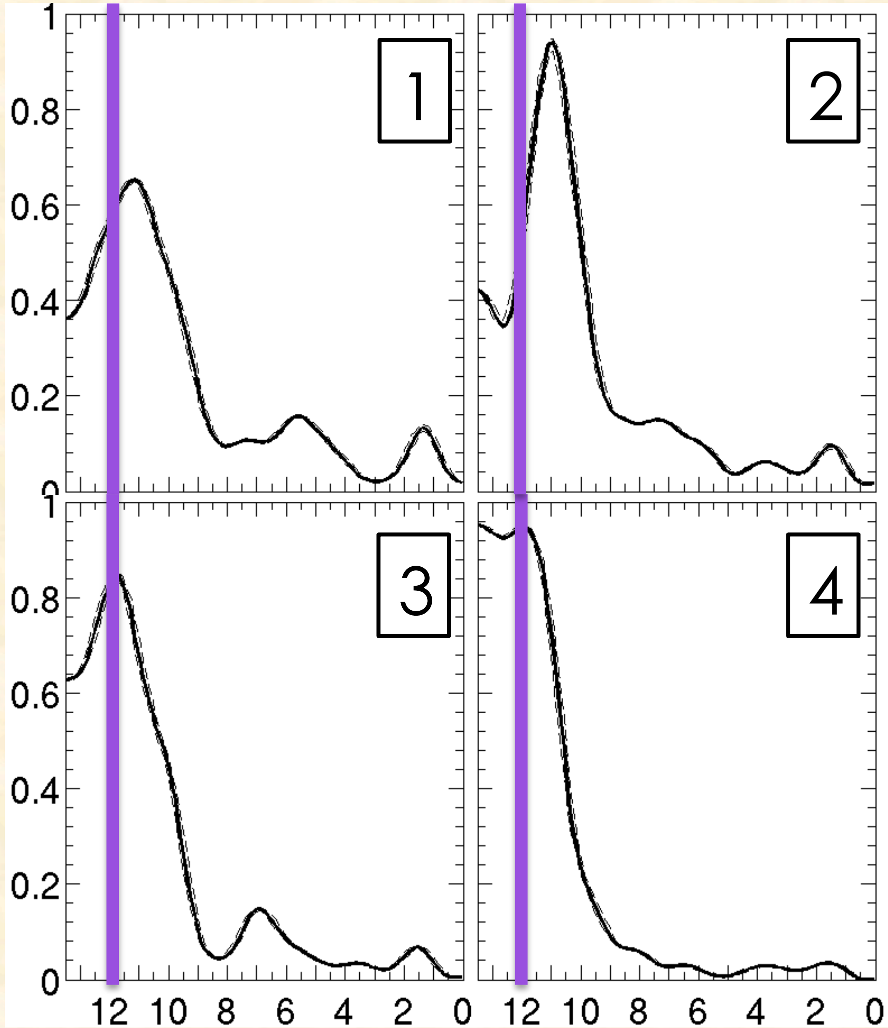
LCID dSph and dT: spatial coverage



Radial variation of SFH in dSph and dT

LGS3

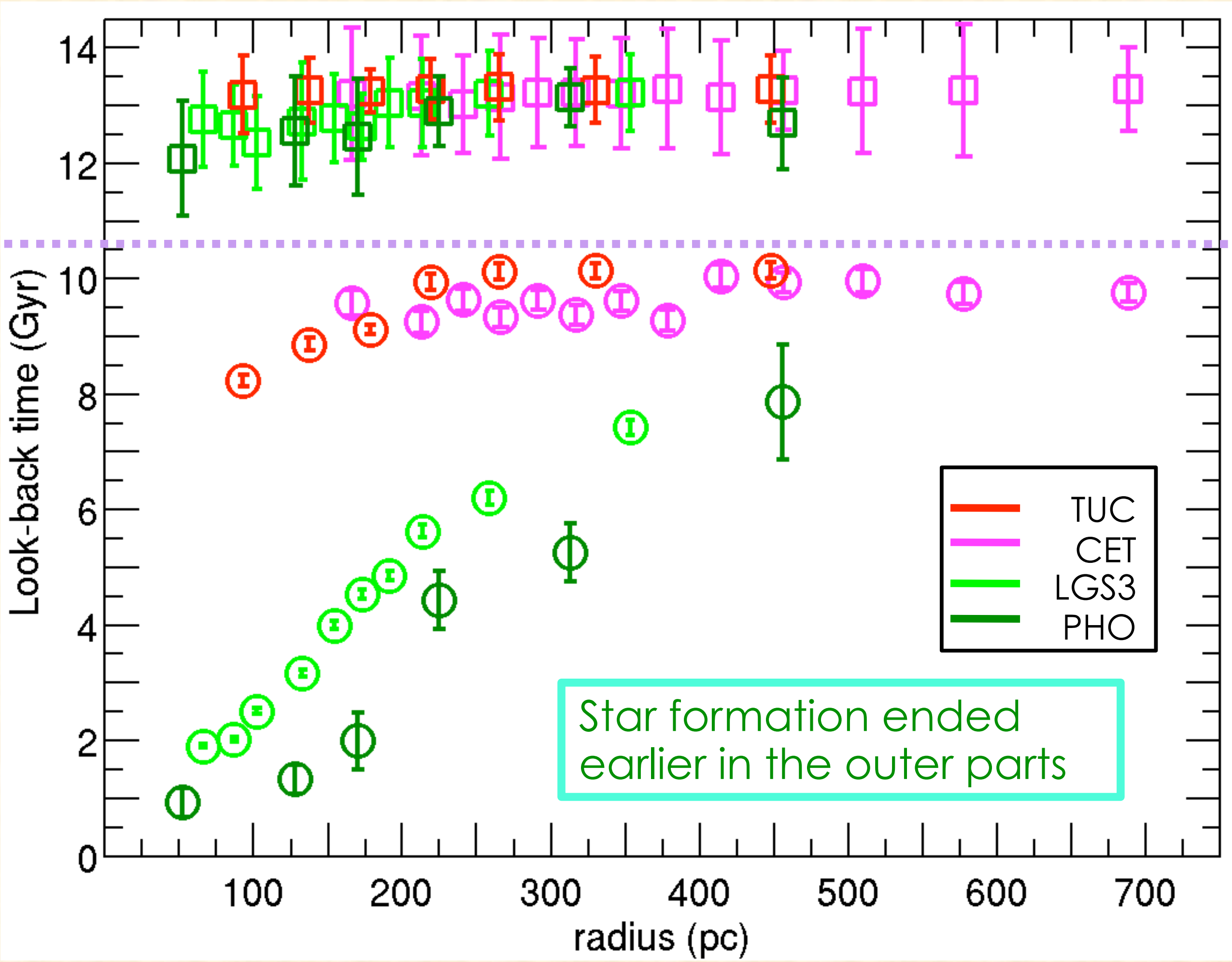




Hidalgo+LCID 2013, ApJ

Look-back time

Radial dependence of SFH in dSph and dT



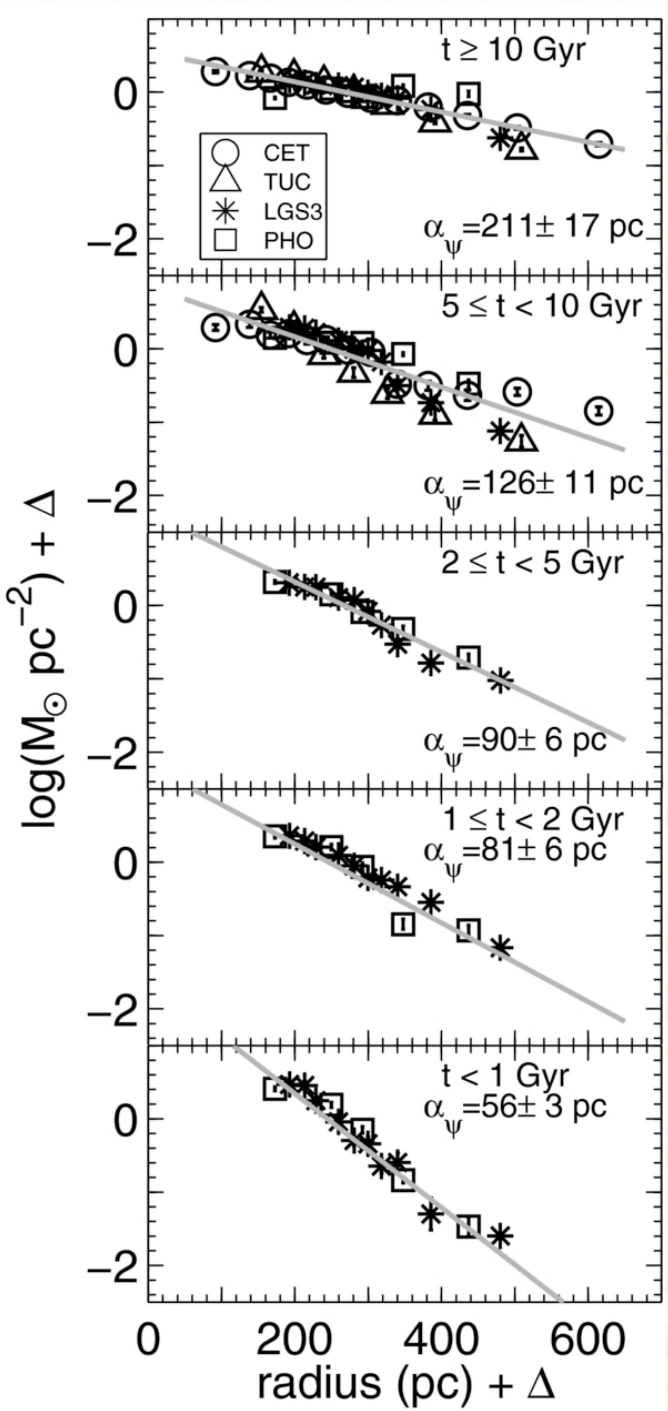
□ 10-percentile of Ψ(t,r)

Age of the first star formation event as a function of radius

○ 95-percentile of Ψ(t,r)

Age of the last star formation event as a function of radius

Hidalgo+LCID 2013, ApJ

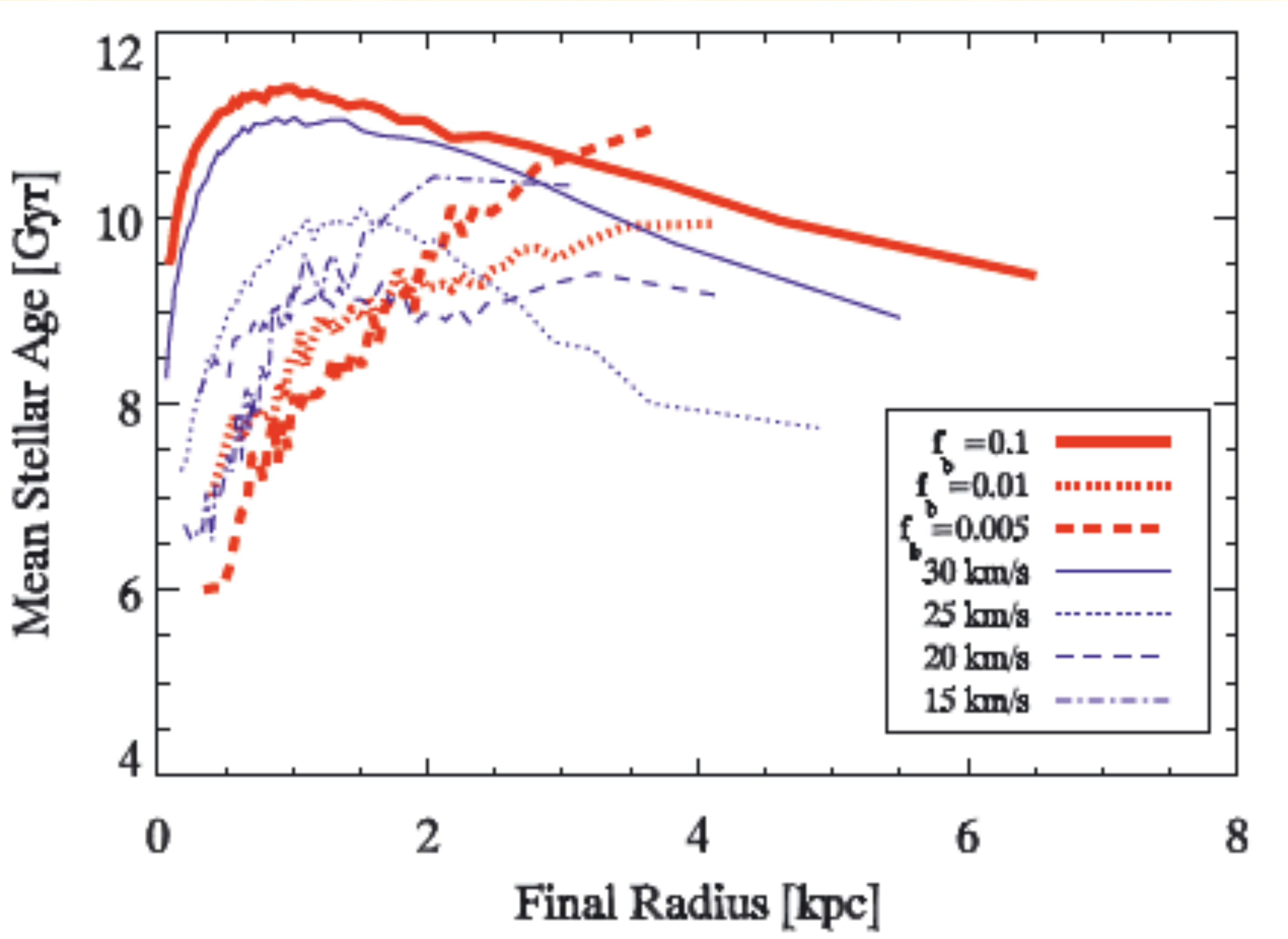


Radial mass distribution as a function of time:

Profile remains exponential at all ages. The scale lenght, α_{ψ}*, of the radial distribution is shown in each panel. An overall decrease of* α_{ψ} *with time is observed.*

Hidalgo+LCID 2013, ApJ

Specific SPH simulations for dwarf galaxies including feedback (Stinson et al. 2009) predict age gradients as observed (older out).

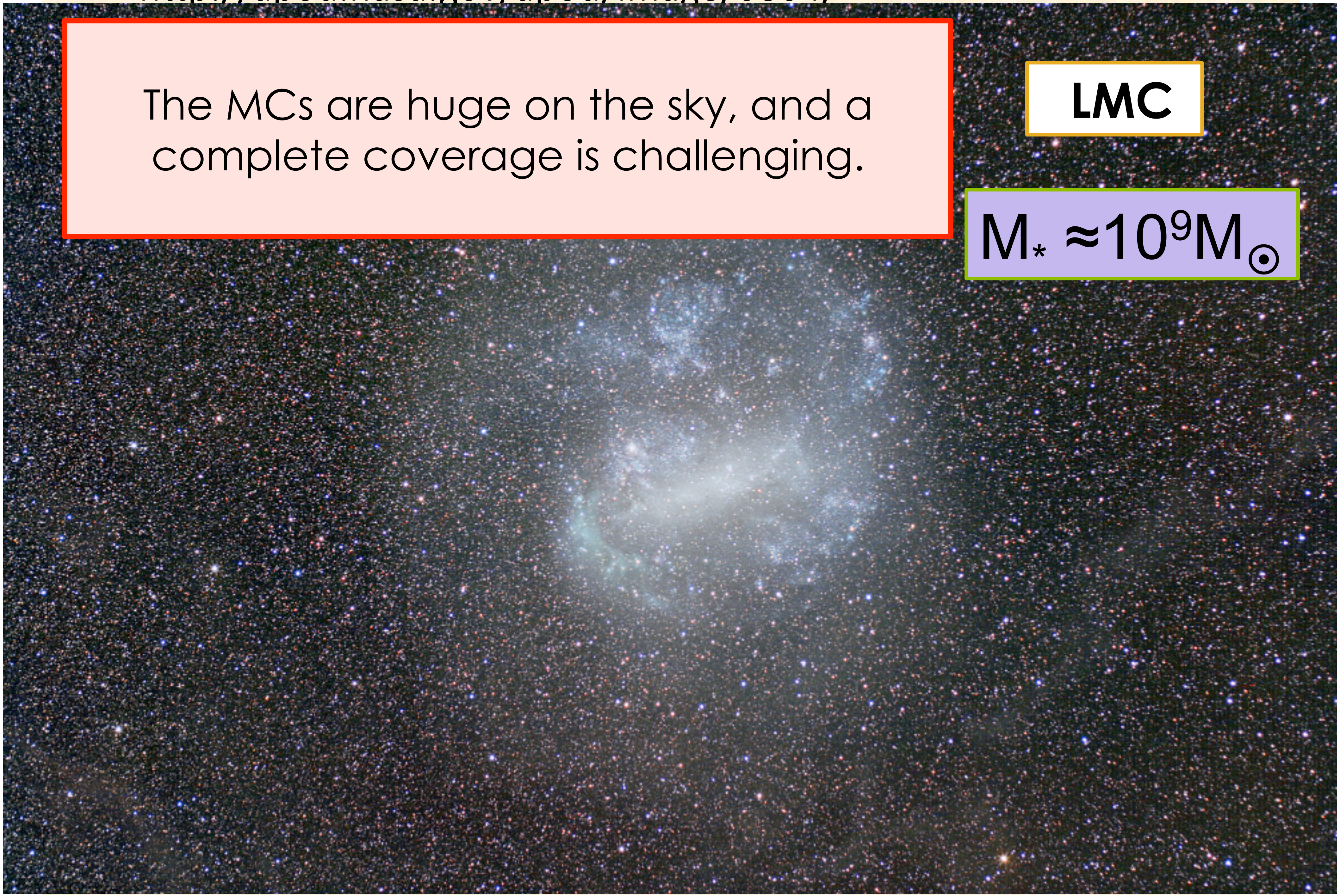


LMC

$M_T \approx 1\text{-}2 \times 10^{10}\ M_{\odot}$
$M_{\star} \approx 4 \times 10^{9}\ M_{\odot}$

V > 35 km/s

http://apod.nasa.gov/apod/image/0804/

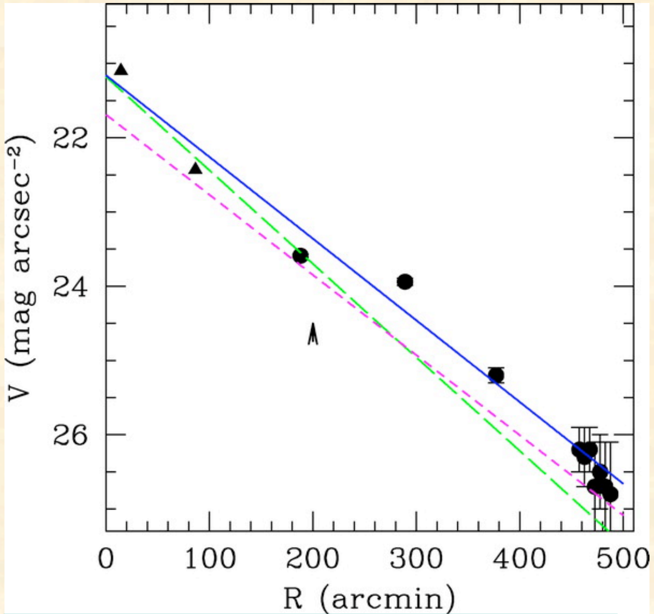


The MCs are huge on the sky, and a complete coverage is challenging.

LMC

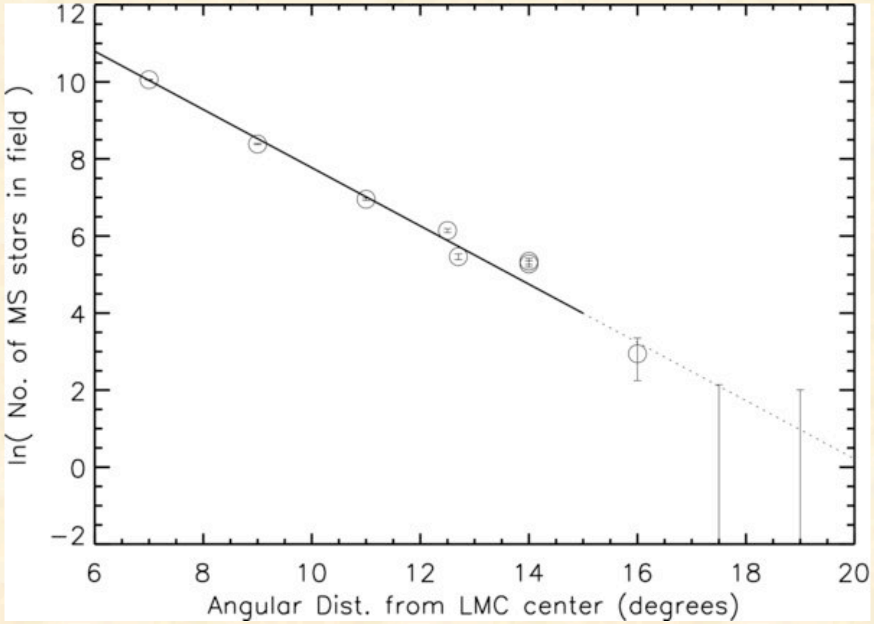
$M_* \approx 10^9 M_\odot$

LMC extends (nicely exponential) out to R≥13°



Gallart et al. 2004, AJ

Saha et al. 2010, AJ



Spatial variations in the star formation history of the Large Magellanic Cloud

CMDs reaching the oldest main sequence turnoffs in

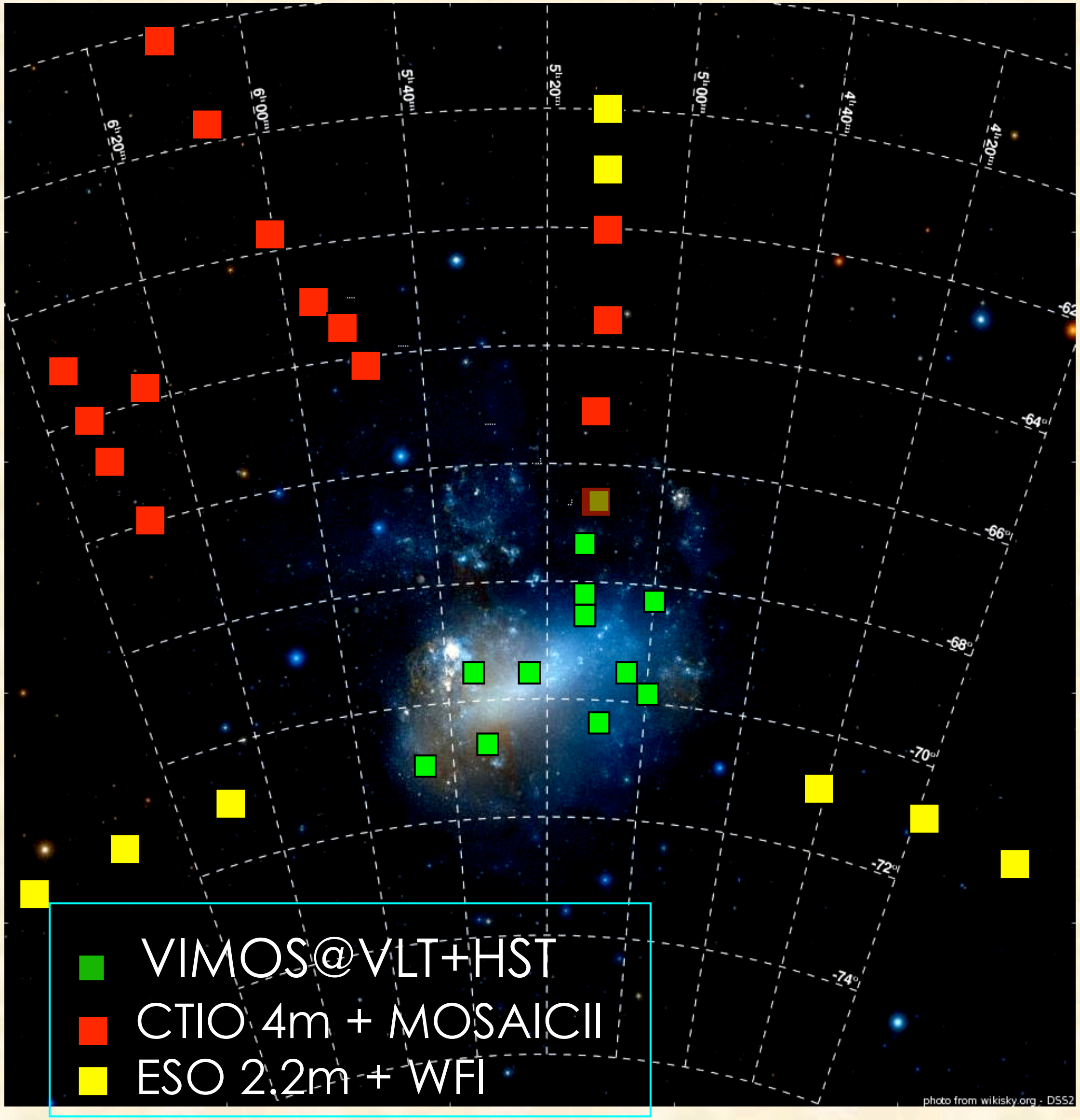
-**outer disk**: 4mCTIO+2.2mESO (35'x35')

-**inner disk**: VLT+VIMOS under 0.6" seeing (15'x15')

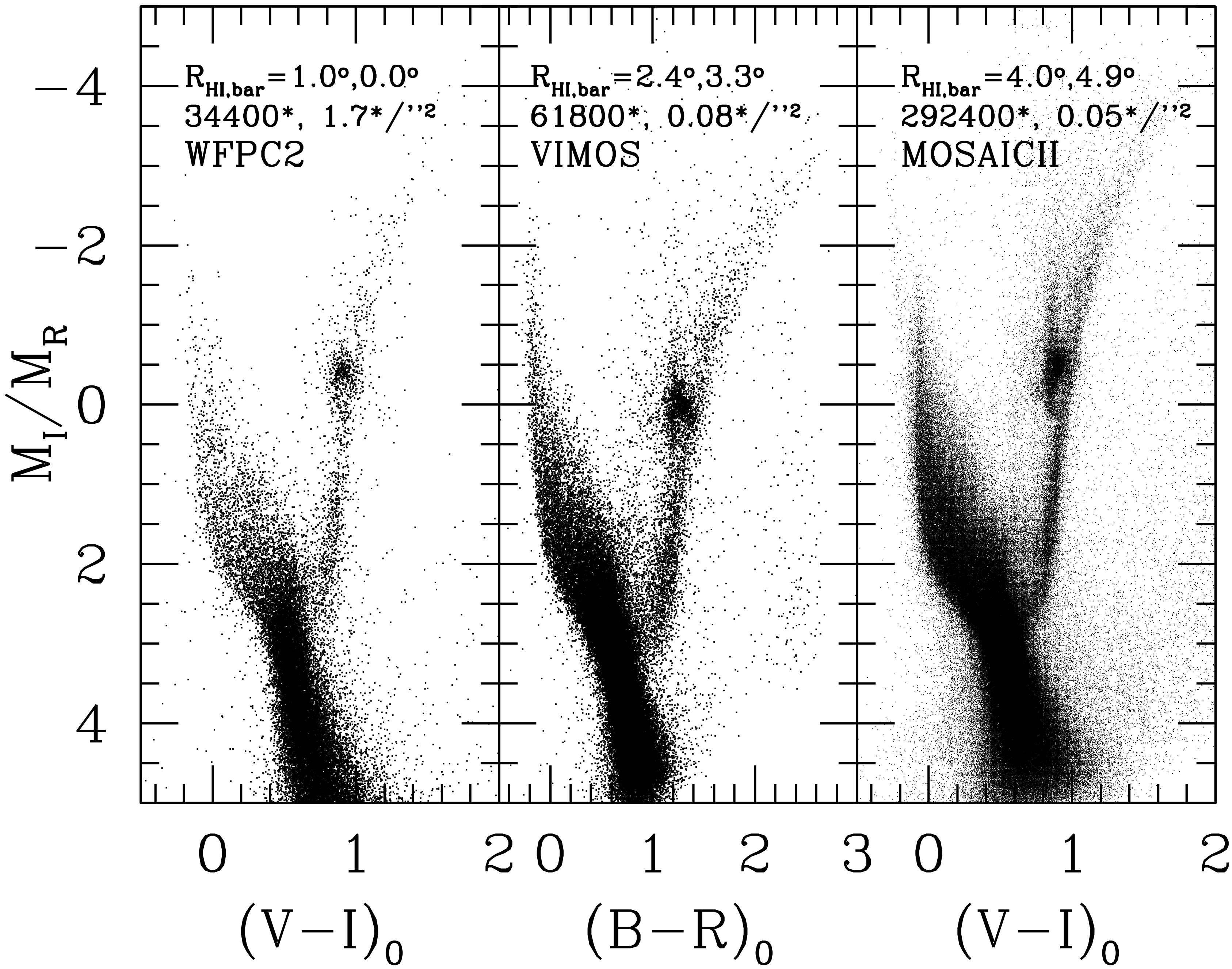
-**bar**: WFPC2/ACS@HST

+

LR CaT spectra for ≈ 900 member stars in 4 fields + FLAMES Medium and HR spectra for ≈300 stars



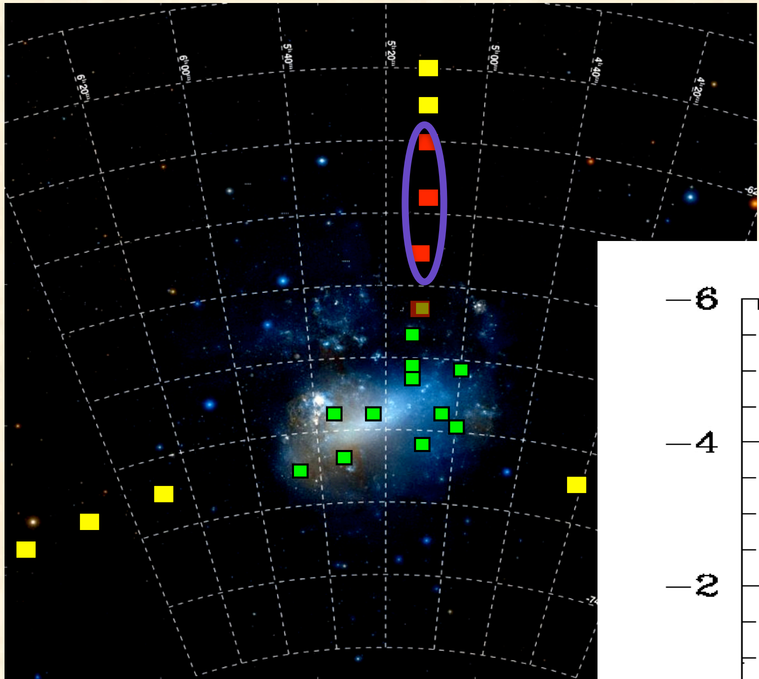
Gallart et al. 2004, 2008
Carrera, CG et al. 2008, 2011
Meschin, CG et al. 2013
Monelli, CG et al. 2014

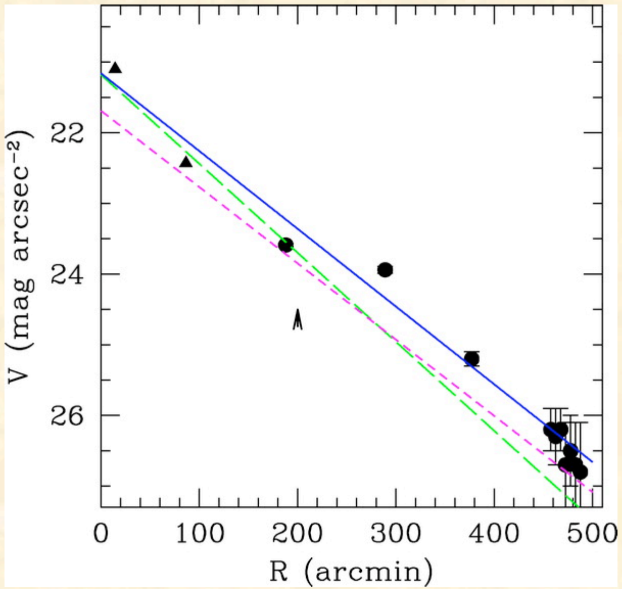


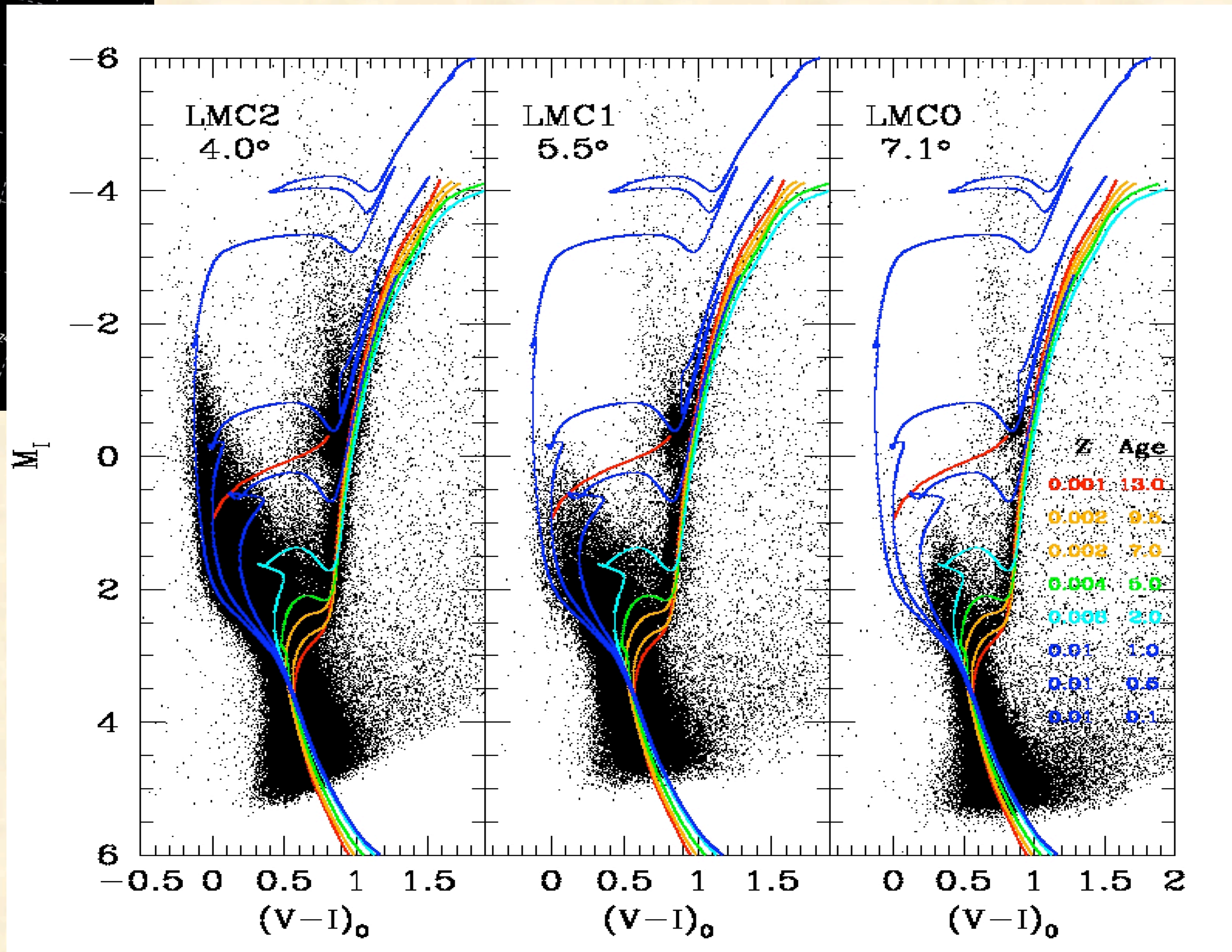
R_HI,bar=1.0°,0.0°
34400*, 1.7*/''2
WFPC2
R_HI,bar=2.4°,3.3°
61800*, 0.08*/''2
VIMOS
R_HI,bar=4.0°,4.9°
292400*, 0.05*/''2
MOSAICII
M_I/M_R
−4
−2
0
2
4
0
1
2
0
1
2
3
0
1
2
(V−I)_0
(B−R)_0
(V−I)_0

Spatial variations in the star formation history of the Large Magellanic Cloud "intermediate disk"

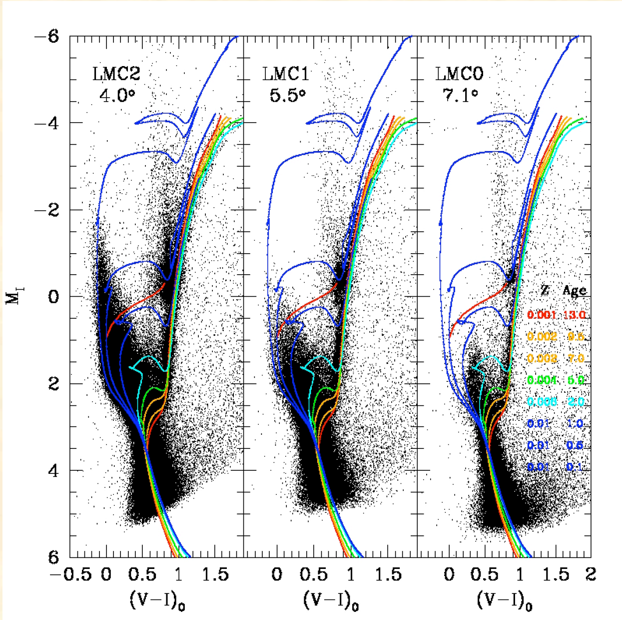
Gallart et al. 2008
Meschin, CG et al. 2014

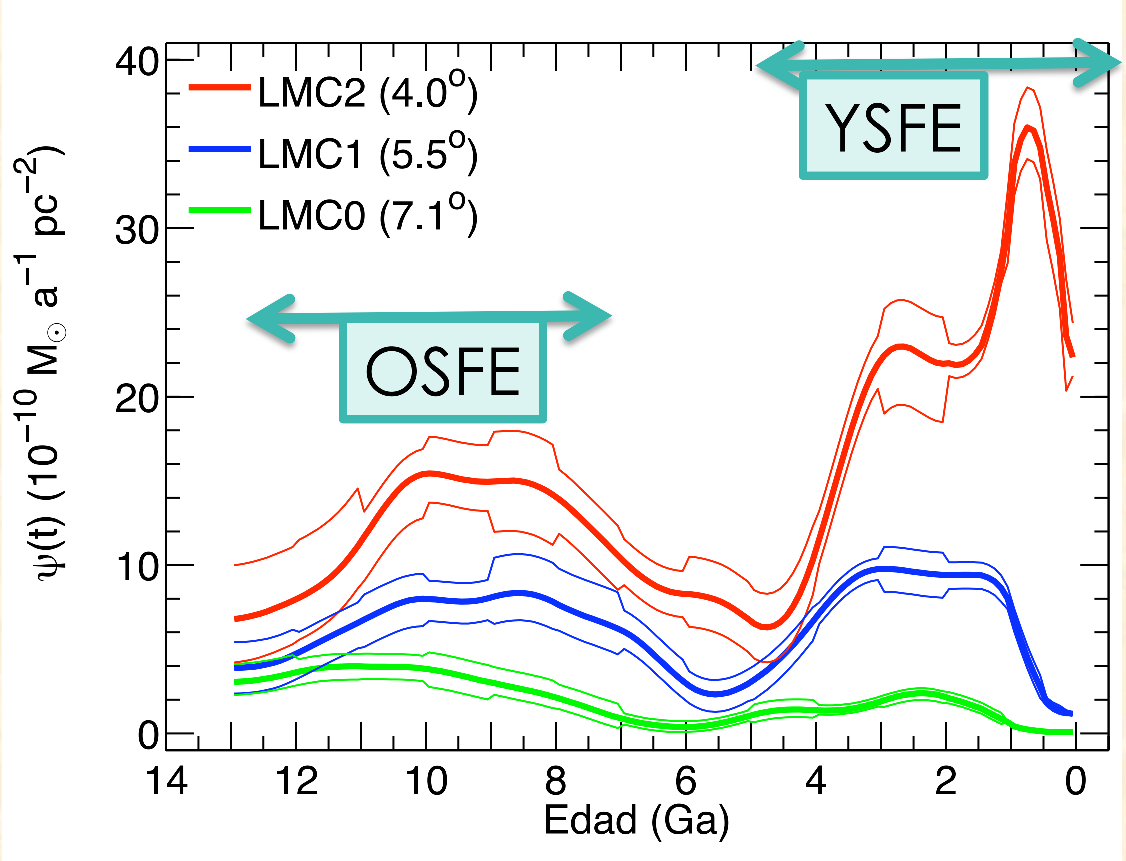




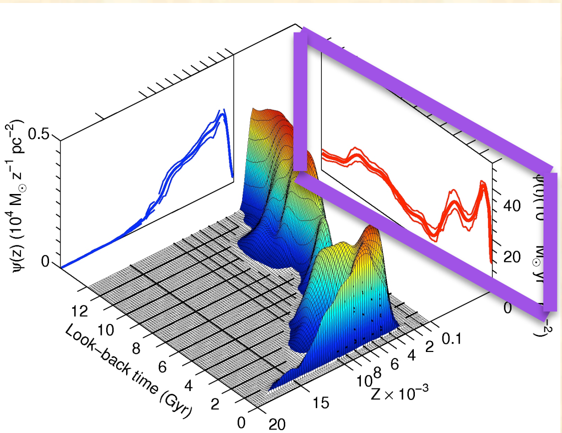


Spatial variations in the star formation history of the Large Magellanic Cloud "intermediate disk"



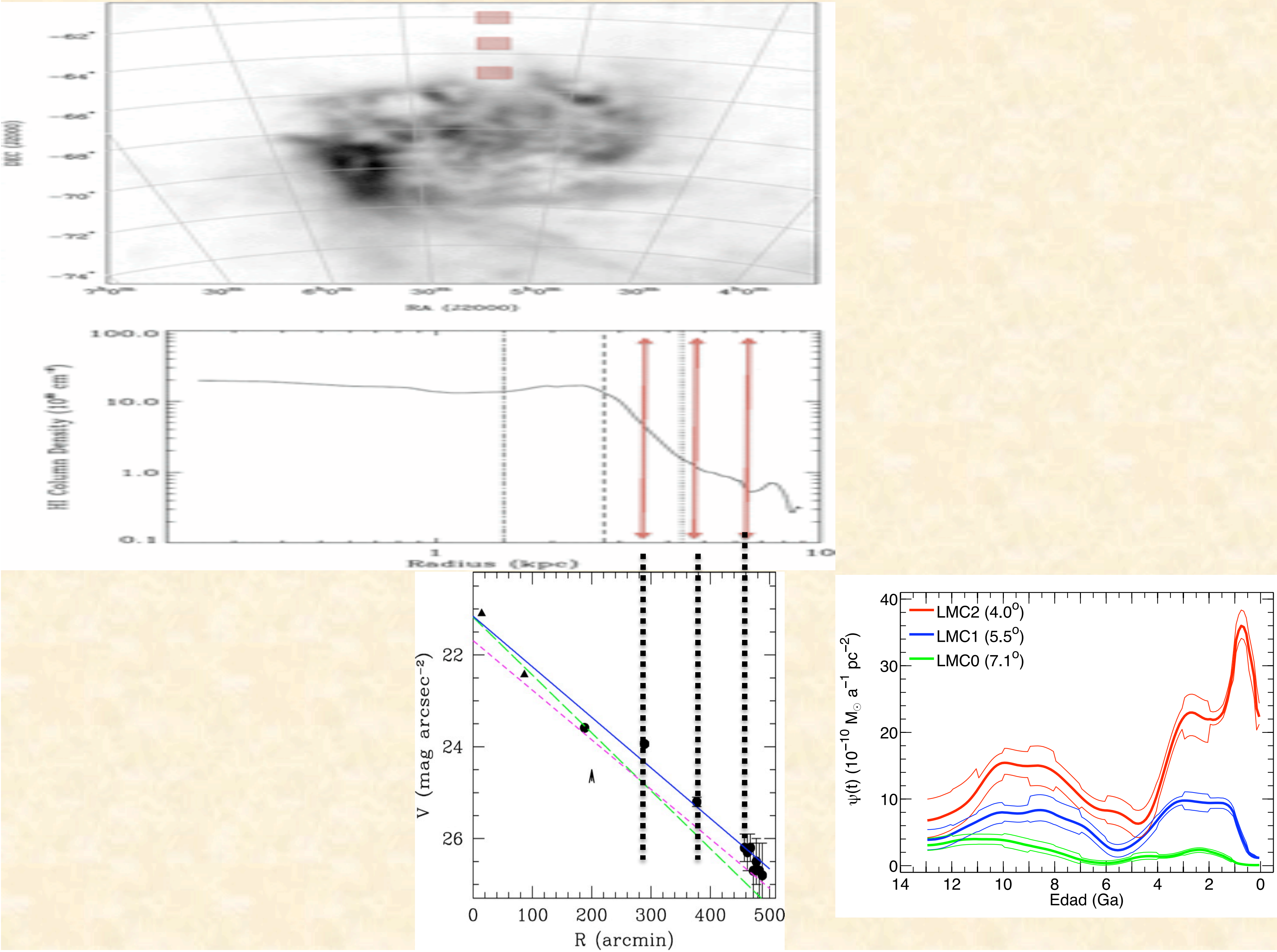


Meschin, CG et al. 2014



The ratio between the amount of star formation in the YSFE and OSFE decreases with increasing galactocentric radius:

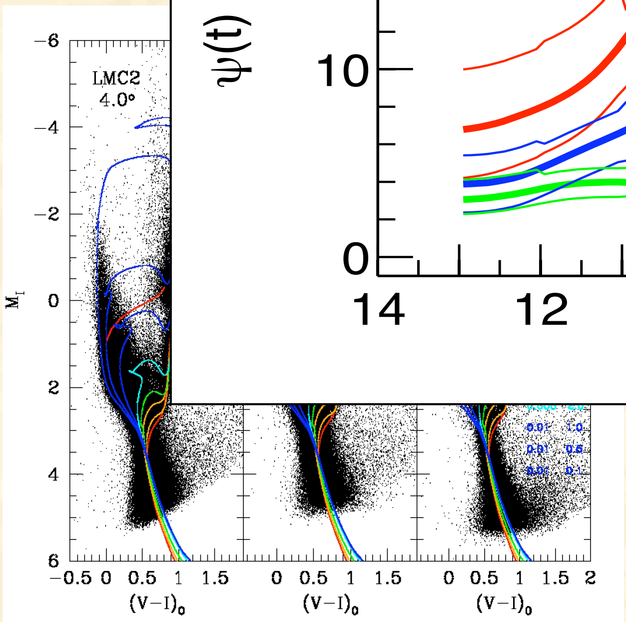
YSFE/OSFE= (1.1:0.8:0.4) for (LMC2:LMC1:LMC0).

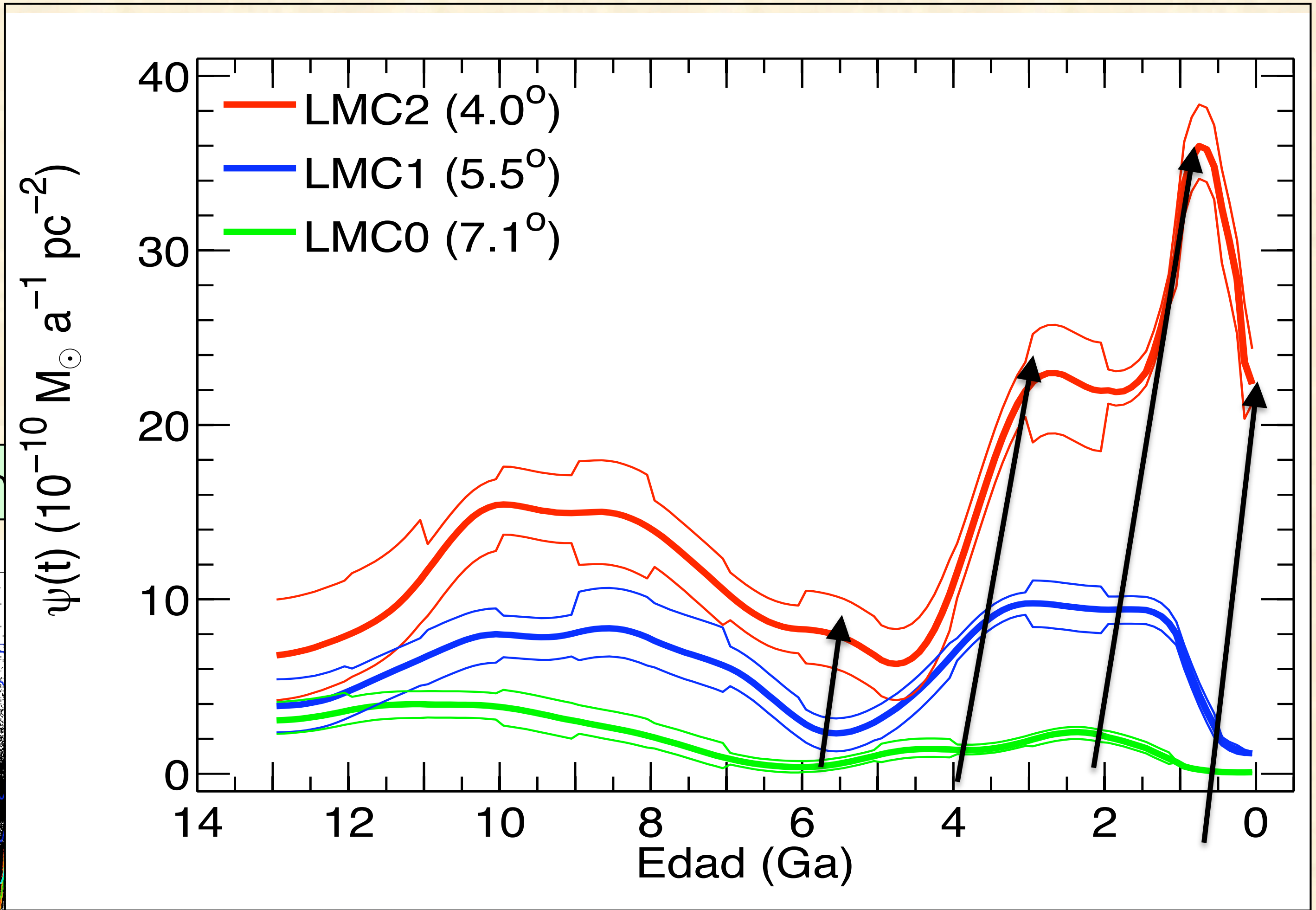


RA (J2000)
Radius (kpc)
V (mag arcsec^{-2})
R (arcmin)
LMC2 (4.0^o)
LMC1 (5.5^o)
LMC0 (7.1^o)
$\psi(t)$ (10^{-10} $M_\odot$ a^{-1} pc^{-2})
Edad (Ga)

Spatial variations in the star formation history of the Large Magellanic Cloud "intermediate disk"

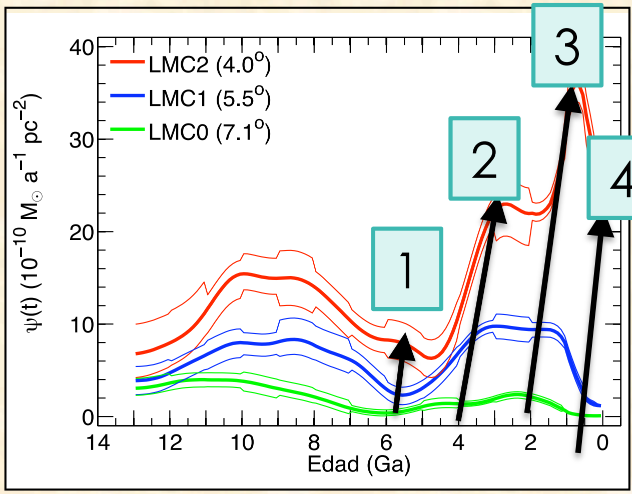
Mesch



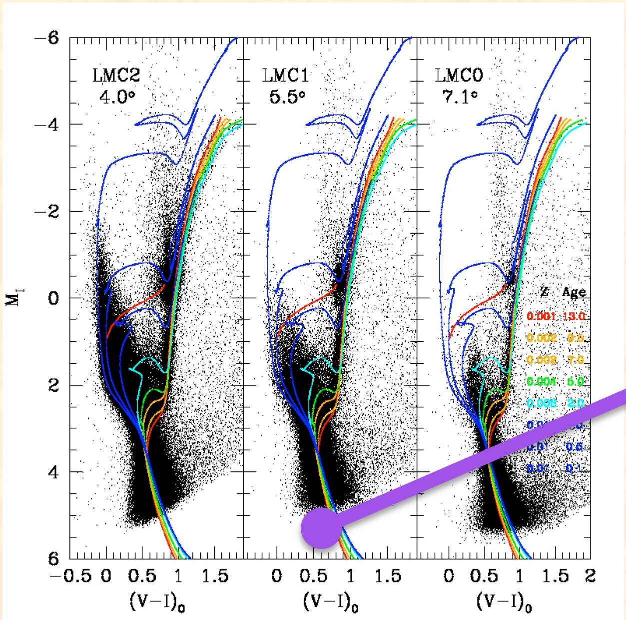


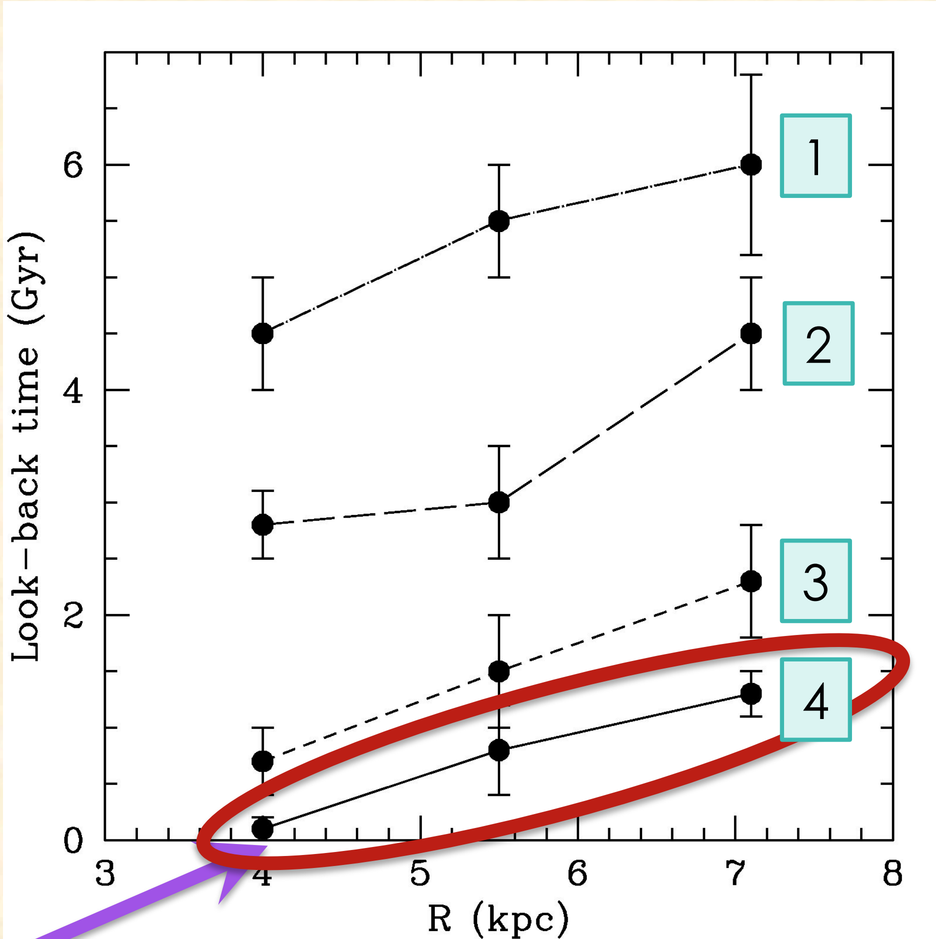
Inwards migrations of various SFH features

Spatial variations in the star formation history of the Large Magellanic Cloud "intermediate disk"



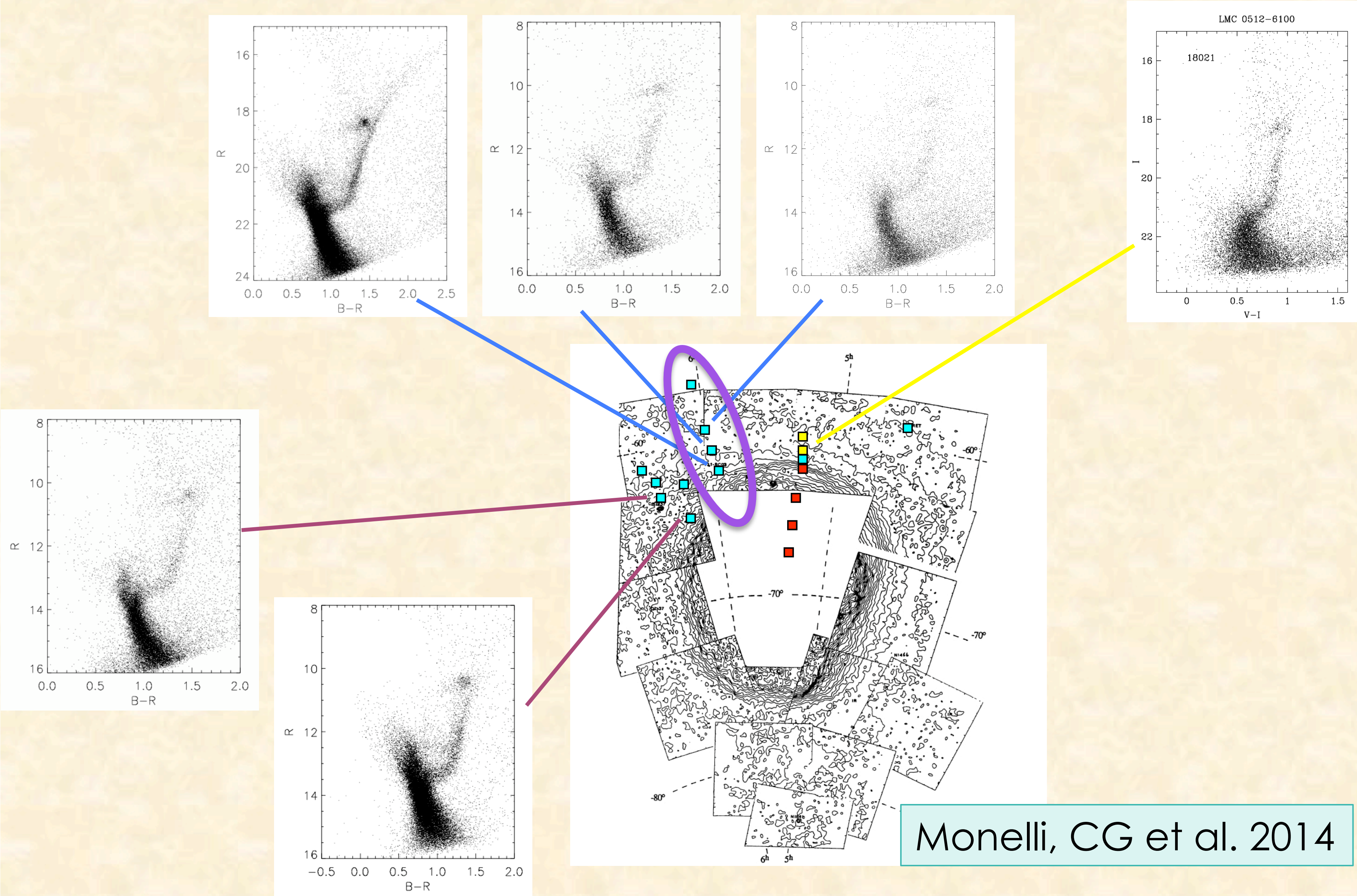
Meschin, CG et al. 2013





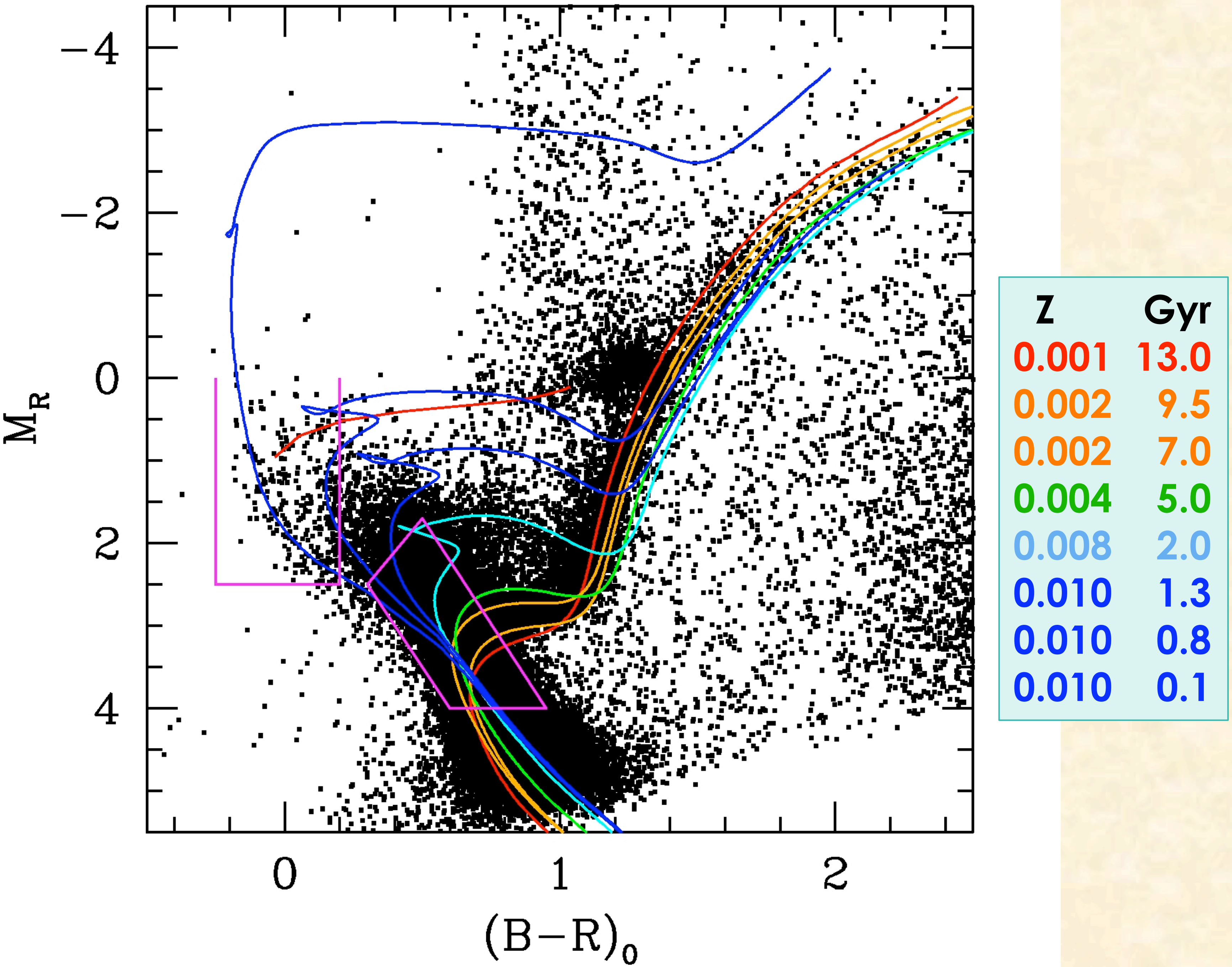
Various features in the SFR(t) 'migrate' as a function of radius at a rate of ≈ 3 Kpc/Gyr.

The outer disk of the Large Magellanic Cloud: the recent evolution



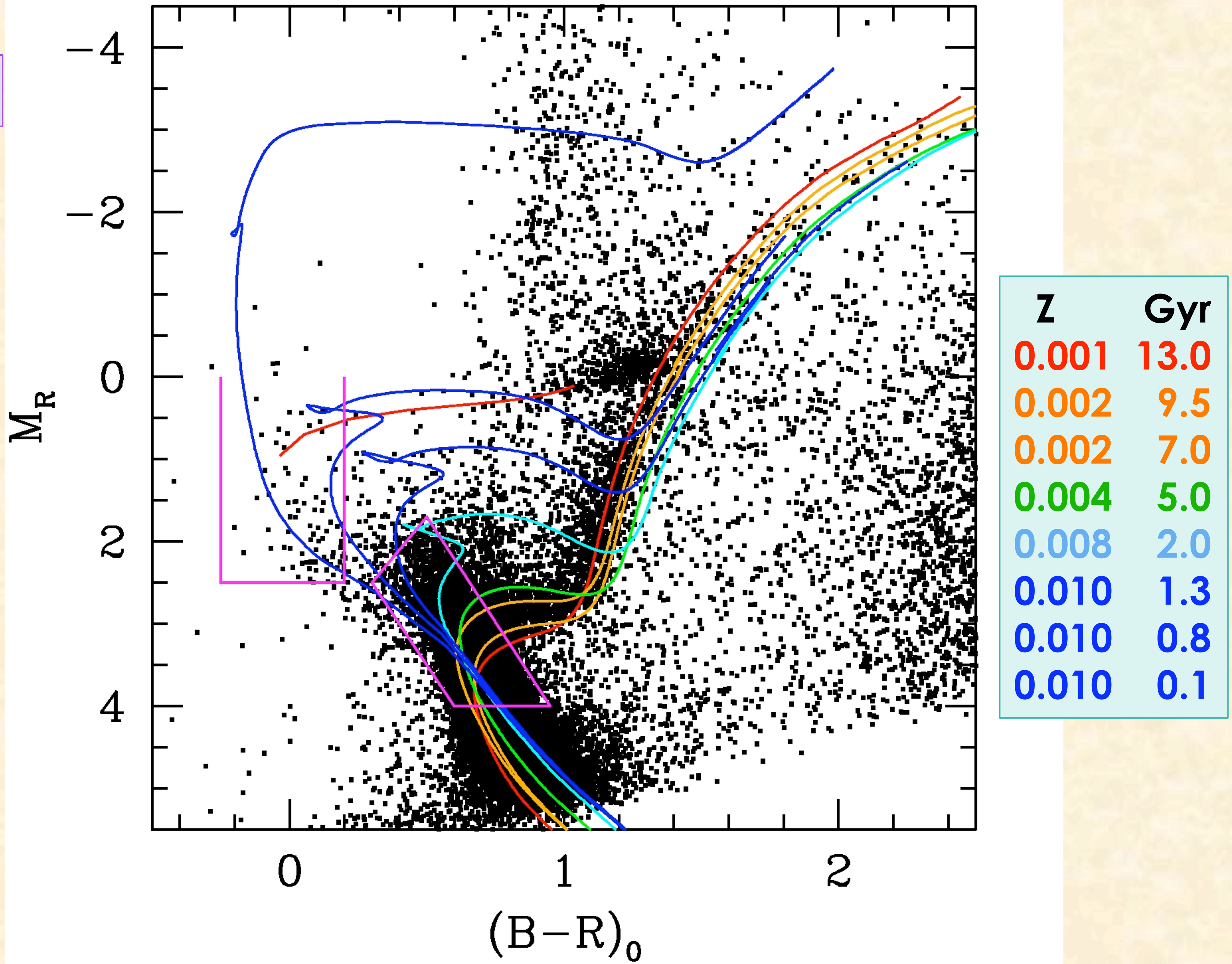
Monelli, CG et al. 2014

R=7.6°



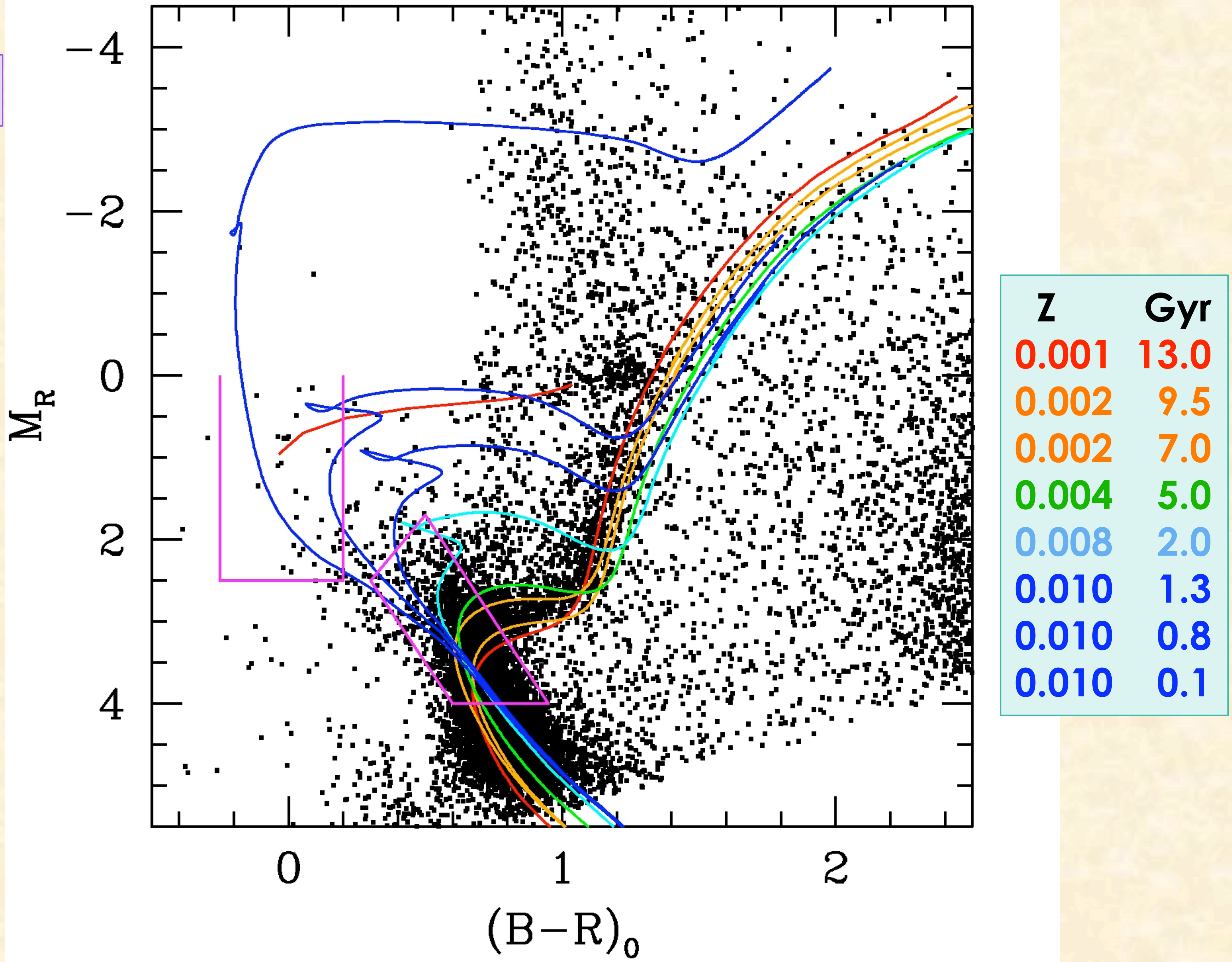
−4
−2
0
2
4
M_R
0
1
2
$(B-R)_0$
Z Gyr
0.001 13.0
0.002 9.5
0.002 7.0
0.004 5.0
0.008 2.0
0.010 1.3
0.010 0.8
0.010 0.1

R=8.3°



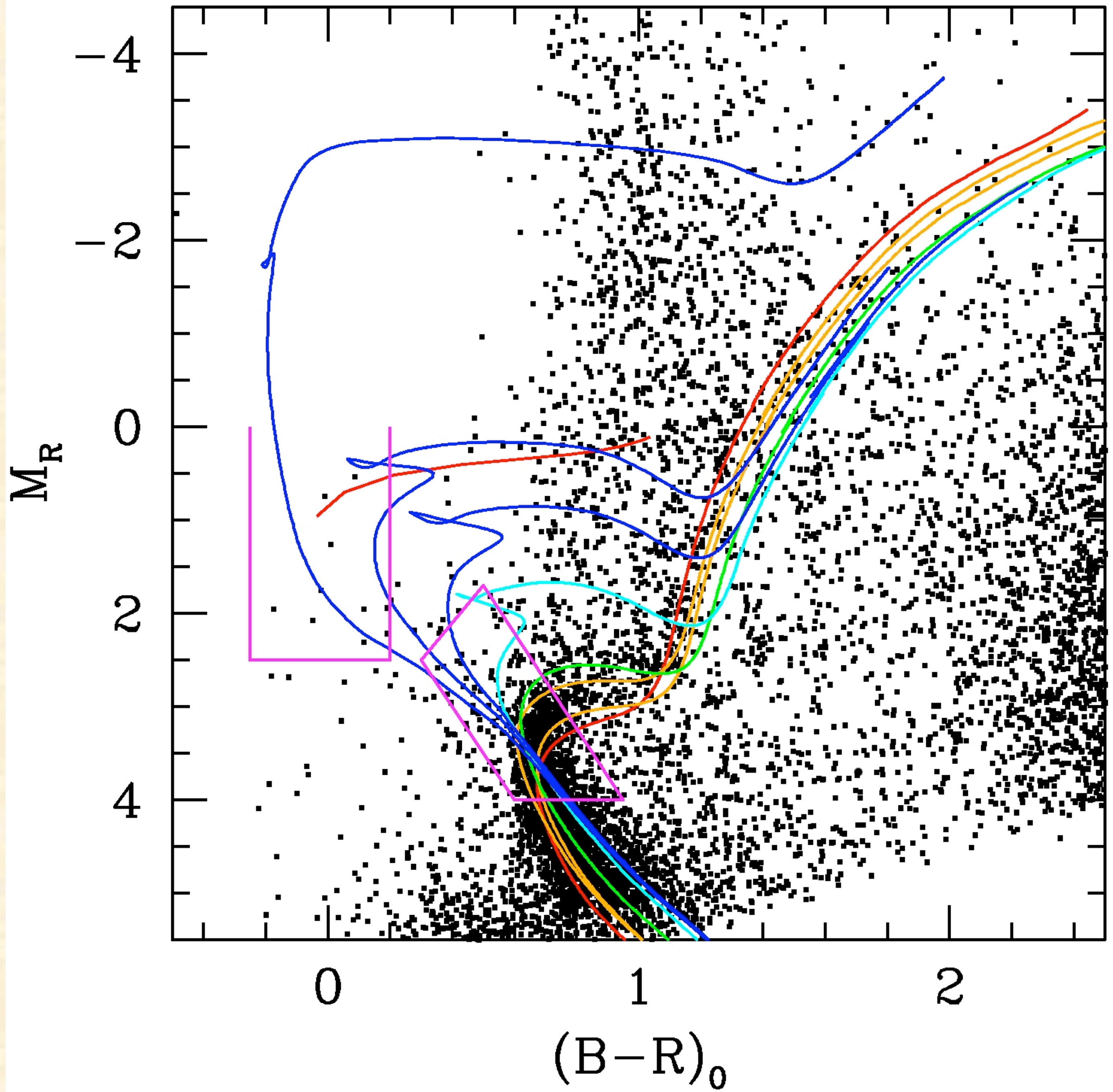
−4
−2
0
2
4
M_R
0
1
2
(B−R)_0
Z Gyr
0.001 13.0
0.002 9.5
0.002 7.0
0.004 5.0
0.008 2.0
0.010 1.3
0.010 0.8
0.010 0.1

R=8.8°



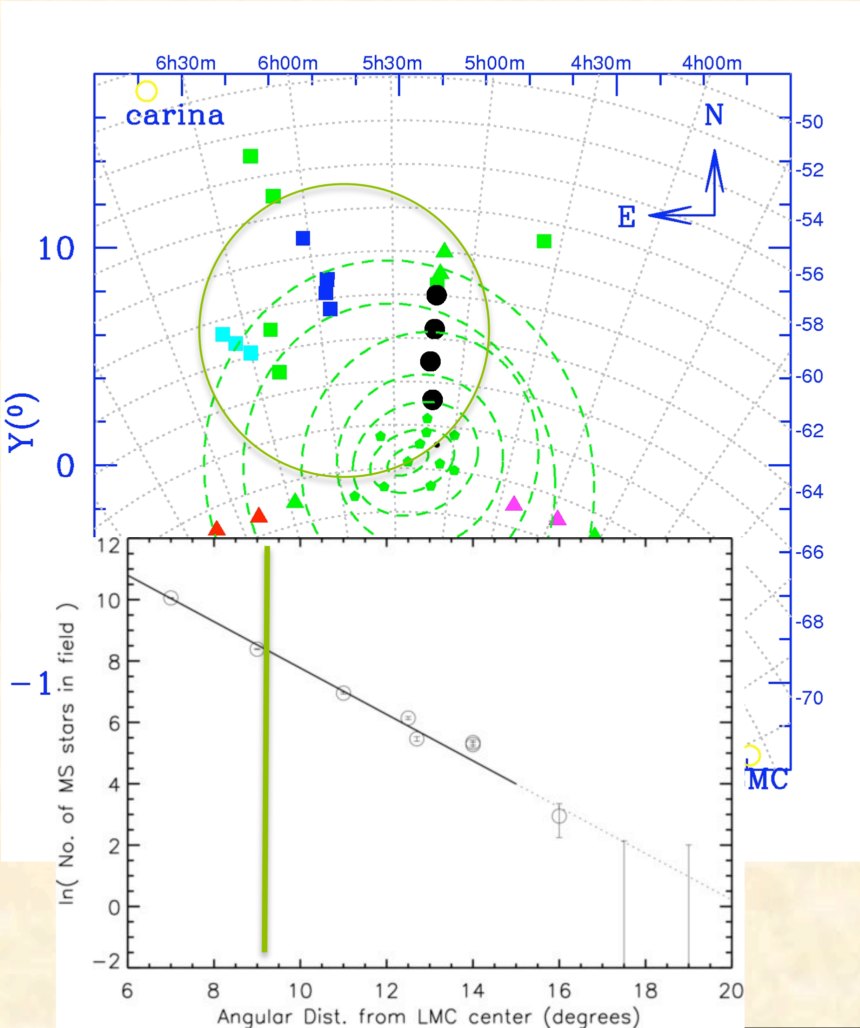
−4
−2
0
2
4
M_R
0
1
2
$(B-R)_0$
Z Gyr
0.001 13.0
0.002 9.5
0.002 7.0
0.004 5.0
0.008 2.0
0.010 1.3
0.010 0.8
0.010 0.1

R=11°

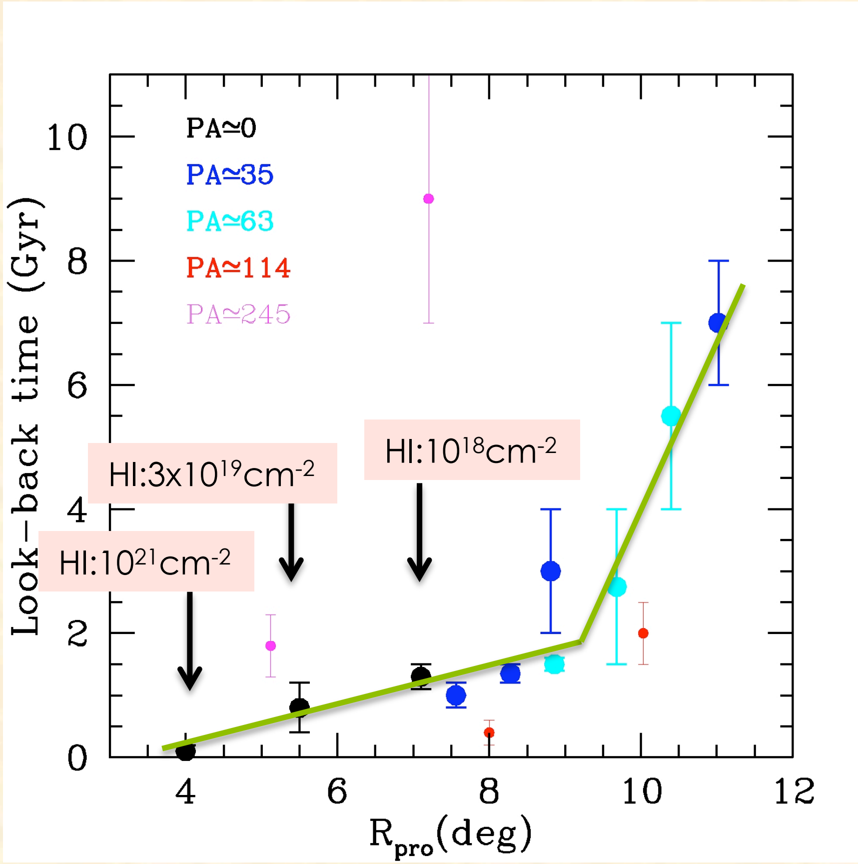


Z	Gyr
0.001	13.0
0.002	9.5
0.002	7.0
0.004	5.0
0.008	2.0
0.010	1.3
0.010	0.8
0.010	0.1

The outer disk of the Large Magellanic Cloud: the recent evolution

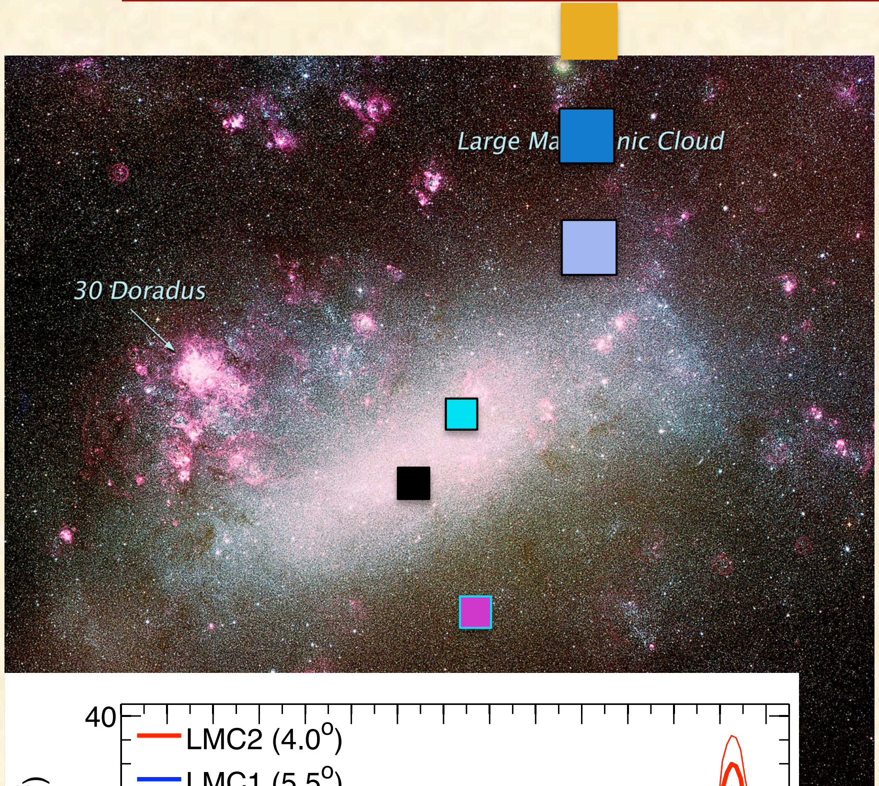


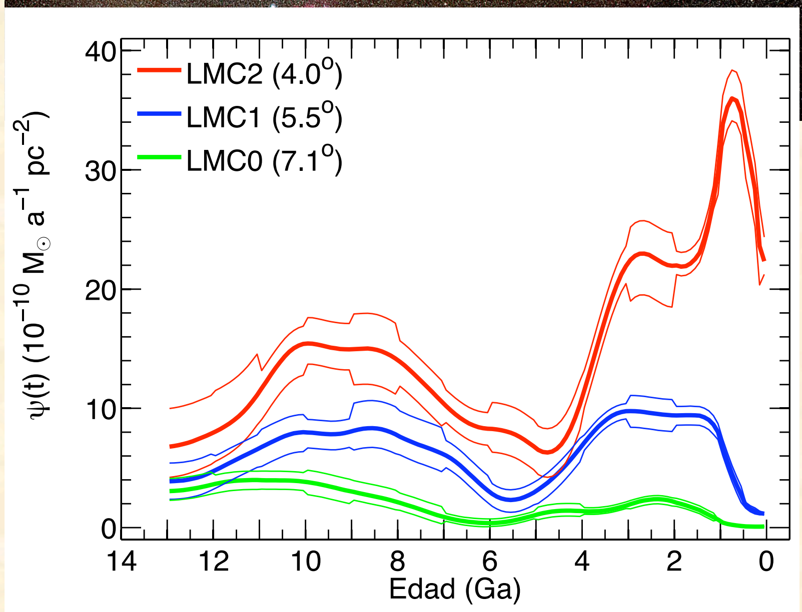
Monelli, CG et al. 2014

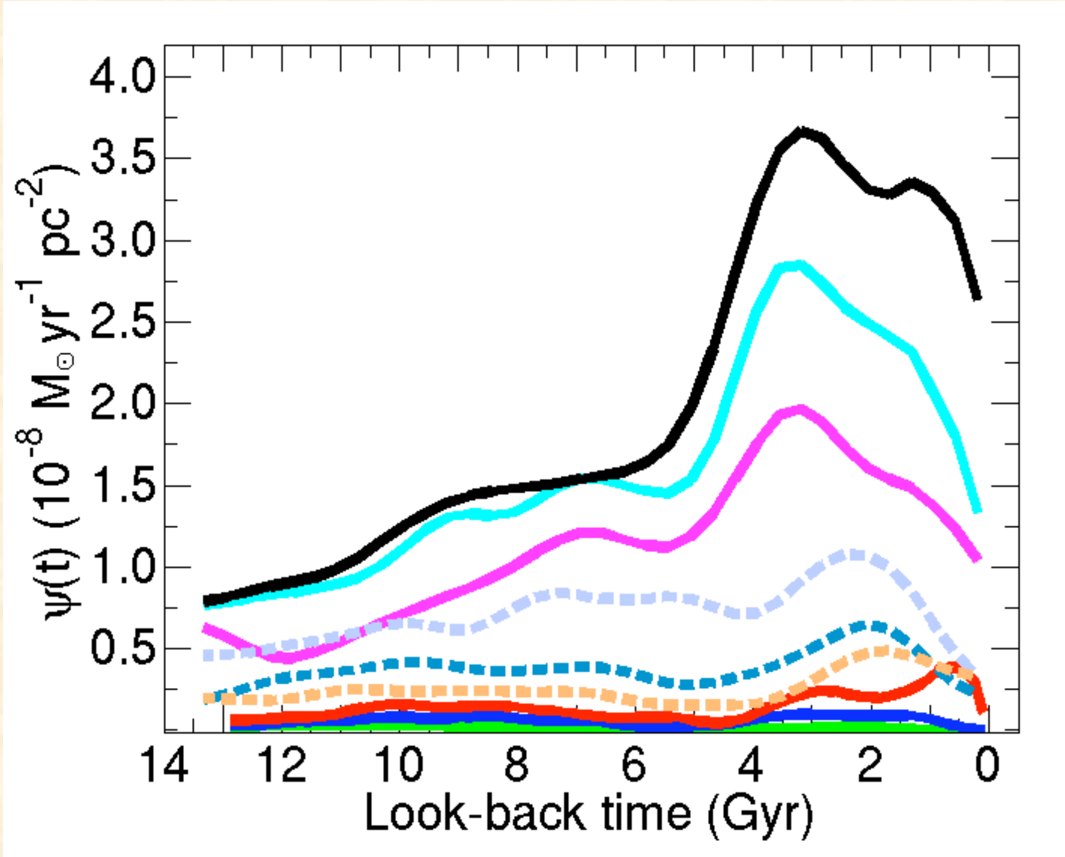


Same migration rate of ≈ 3 Kpc/Gyr for the age of the end of the star formation out to ≈9 Kpc

The star formation history of the LMC inner disk and bar from VIMOS@VLT+ WFPC2@HST imaging

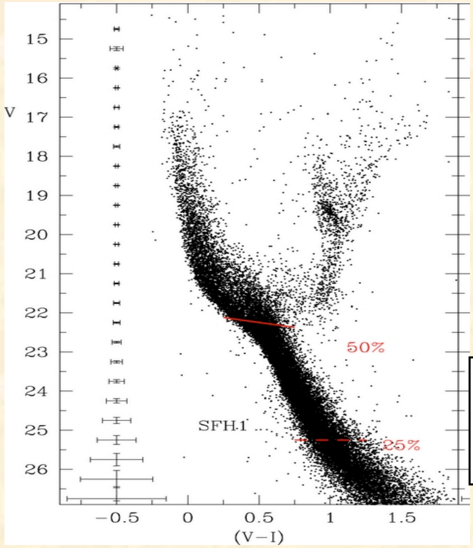


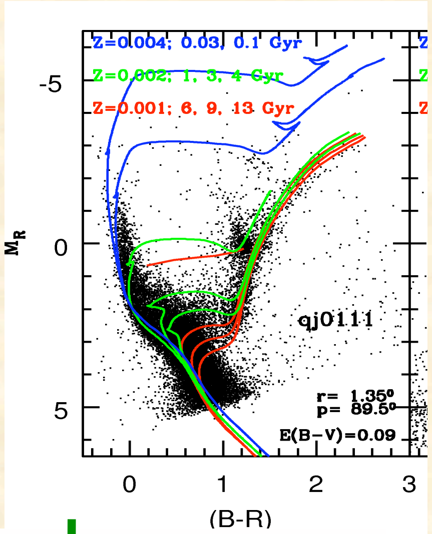




Monelli, CG et al., in prep

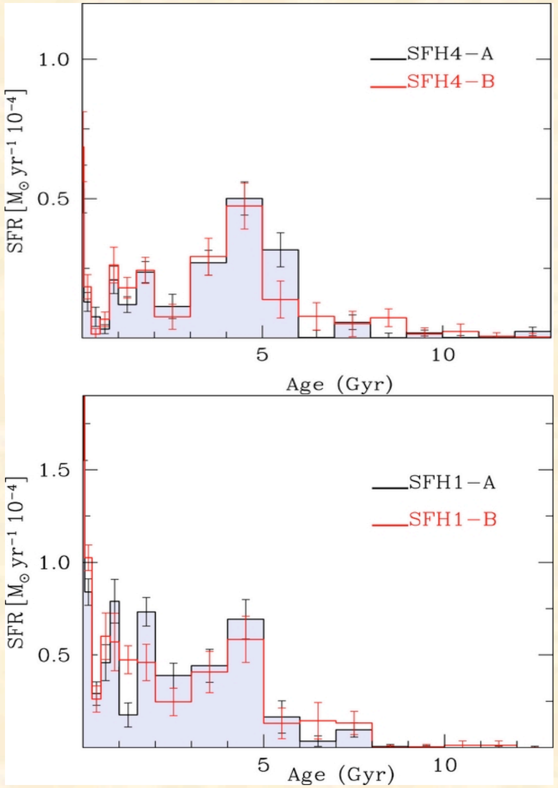
The SFH of the Small Magellanic Cloud

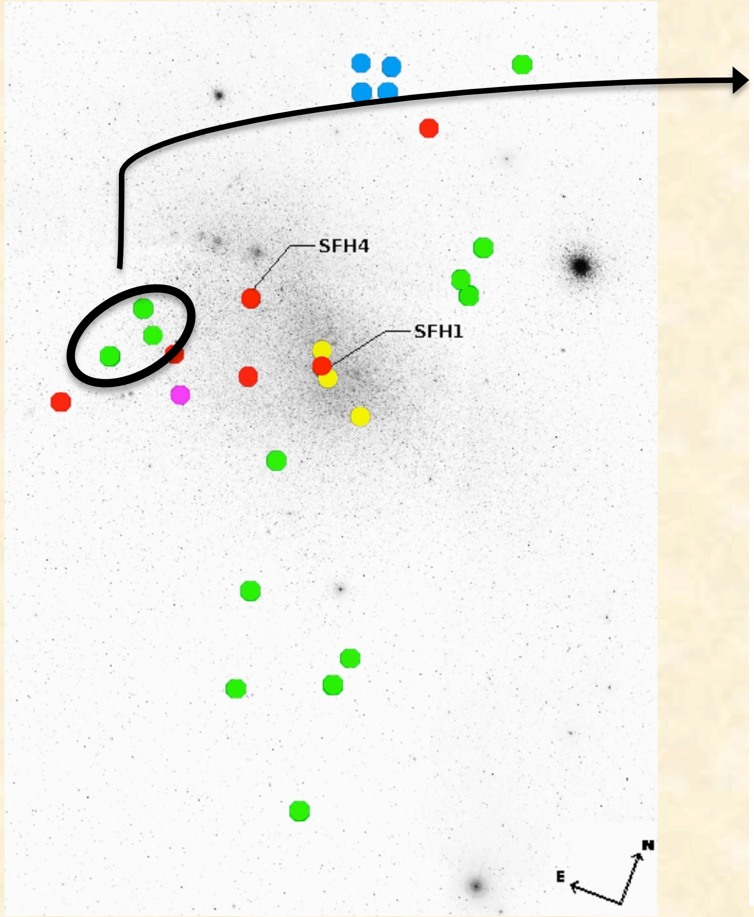


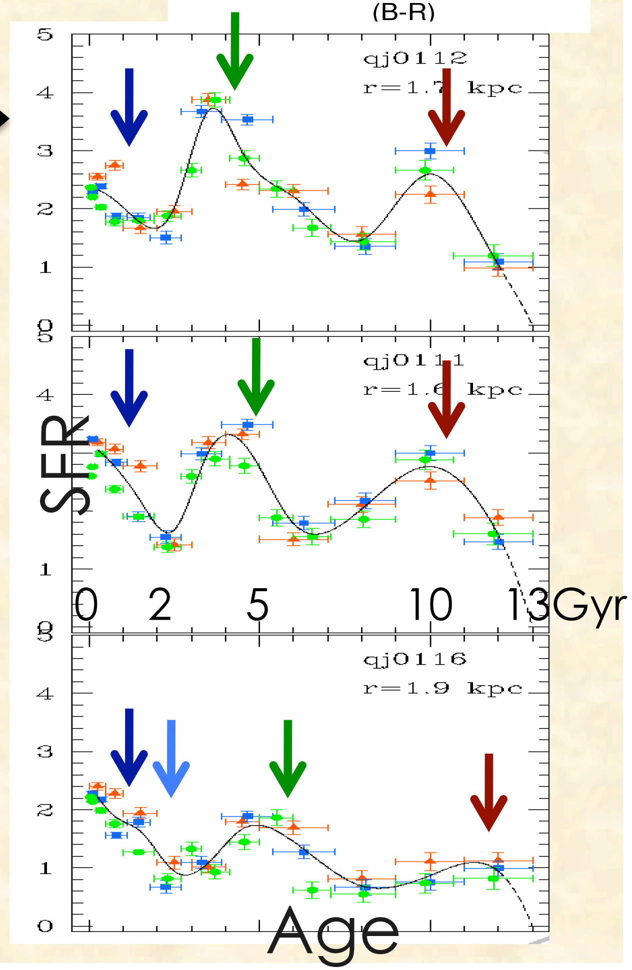


Cignoni et al. 2012
2 out of 6 ACS fields

Noël, CG et al. 2007
-12 LCO 100“ fields







Survey of the MAgellanic Stellar History: SMASH

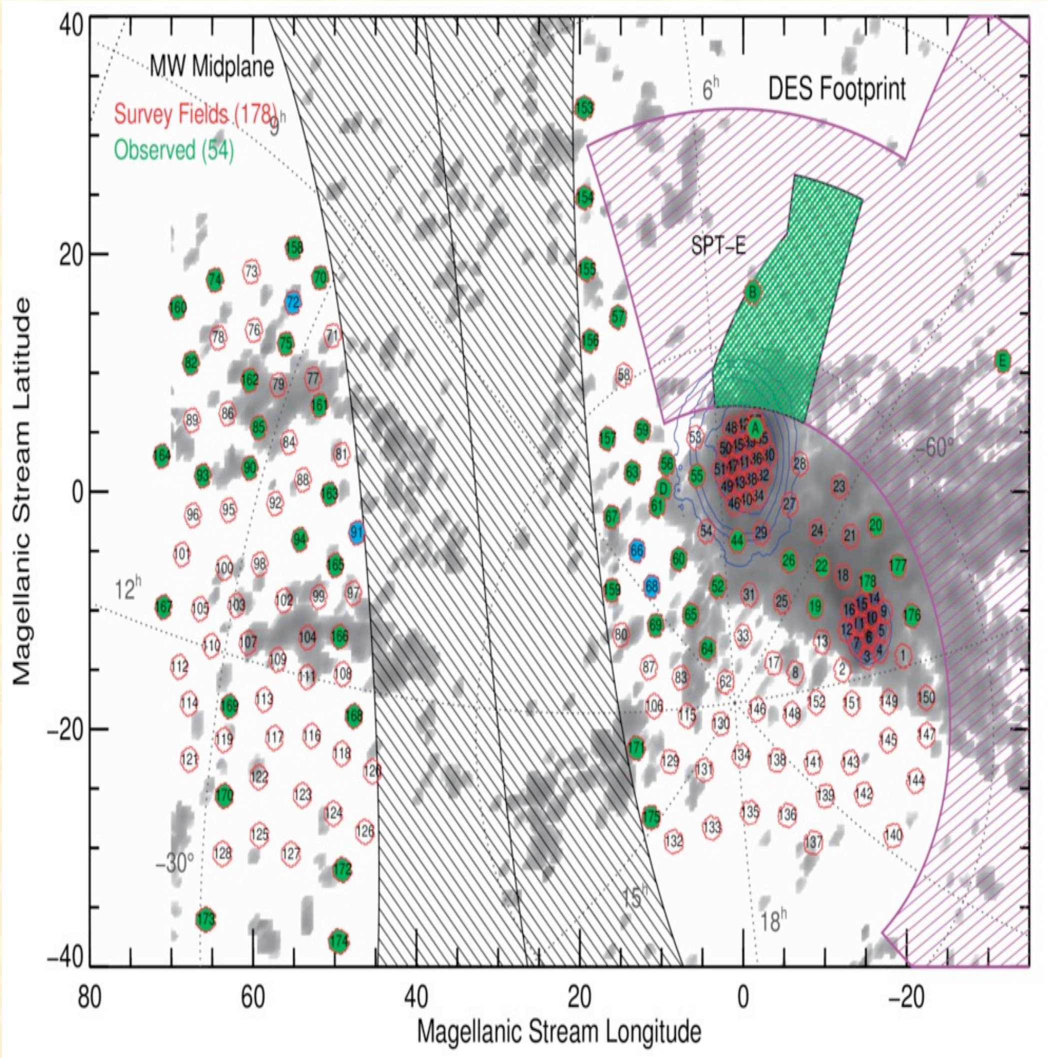
- 40 nights with CTIO/DECam
- 480 deg^2 distributed over 2500 deg^2 complementary to DES footprint
- ugriz filters, to 24th mag
- 30 researchers, P.I. D. Nidever

<u>GOALS:</u>

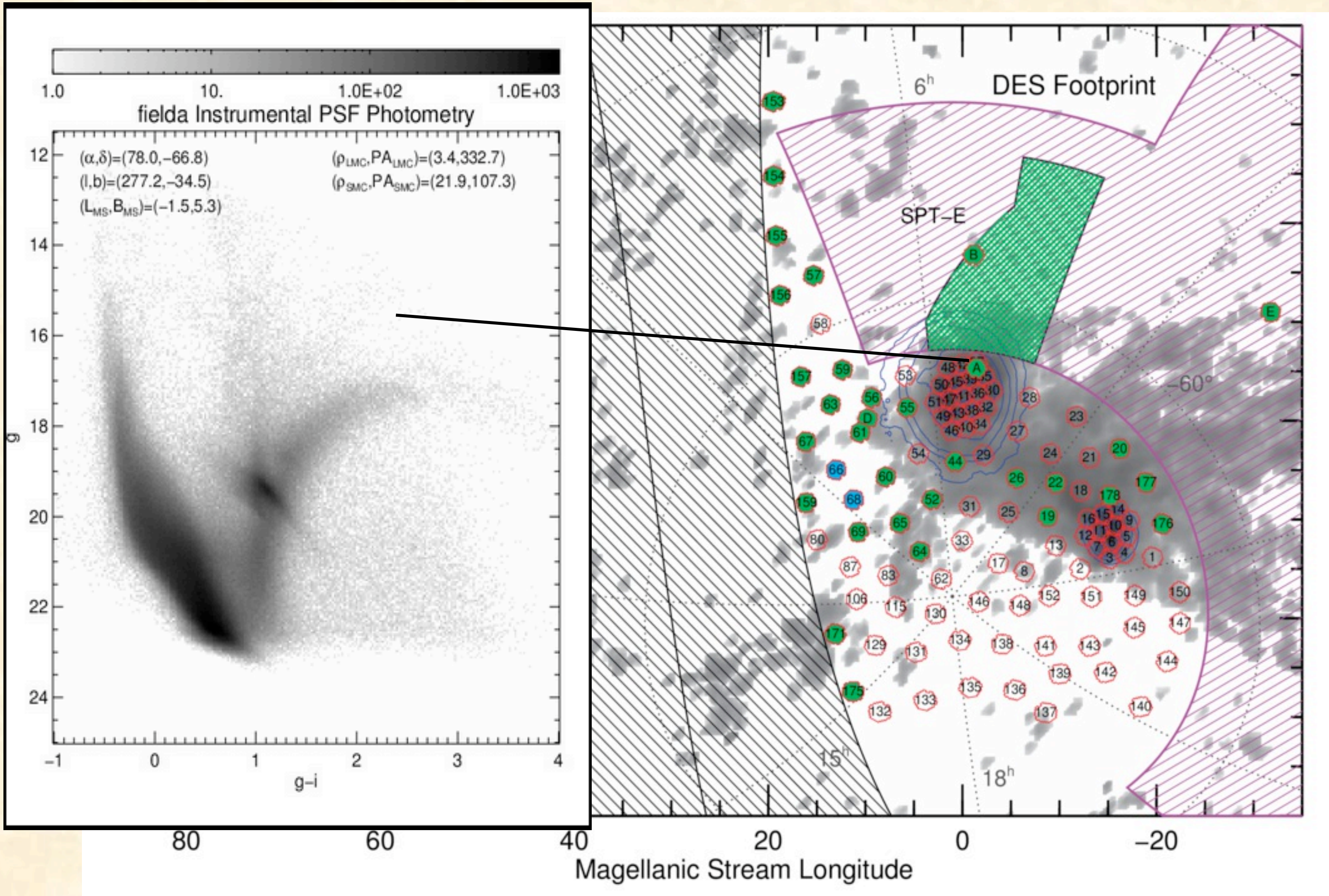
-Map the Magellanic stellar periphery with old main-sequence turnoff stars revealing relics of their formation and past interactions

- Search for the stellar component of the Magellanic Stream and Leading Arm

- Derive spatially-resolved star formation histories covering all ages out to large radii

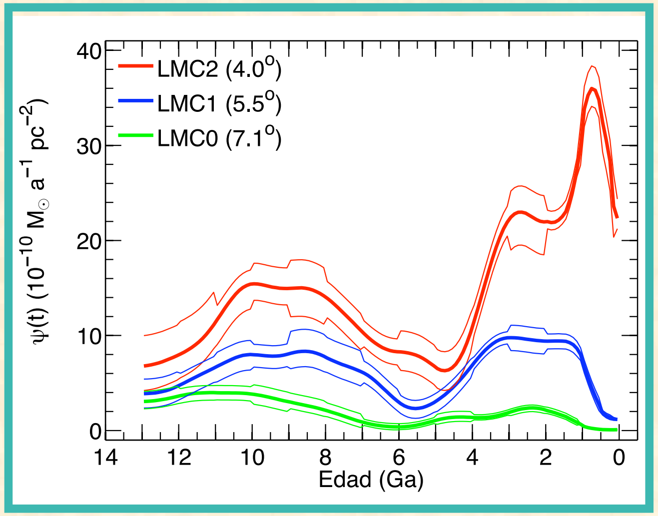


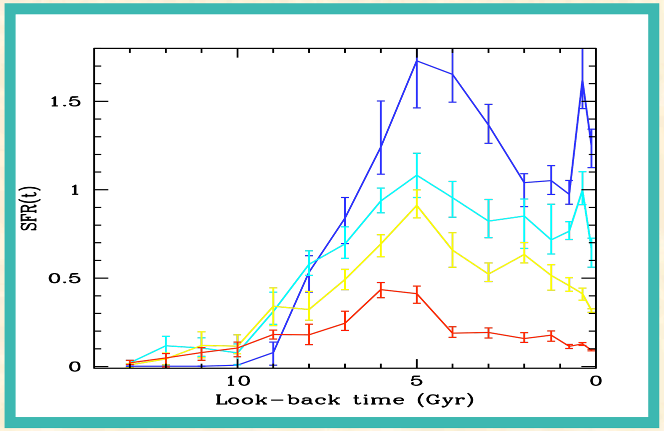
Survey of the MAgellanic Stellar History: SMASH

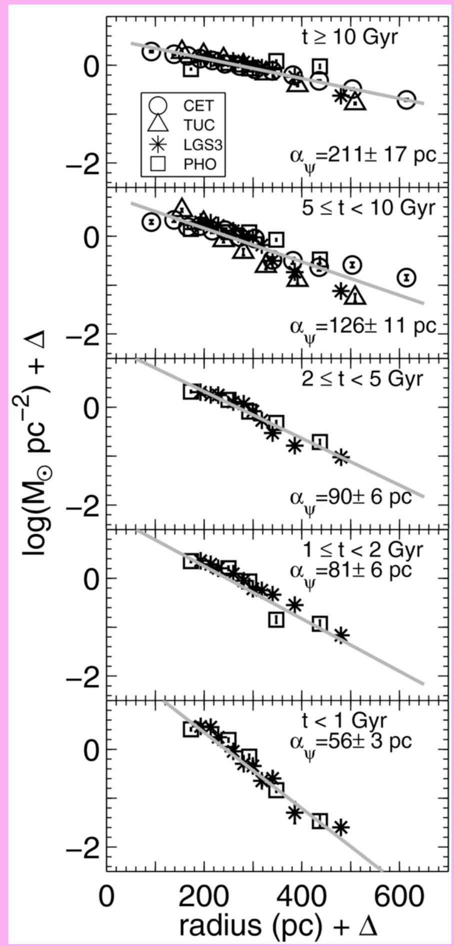


Summary and conclusions

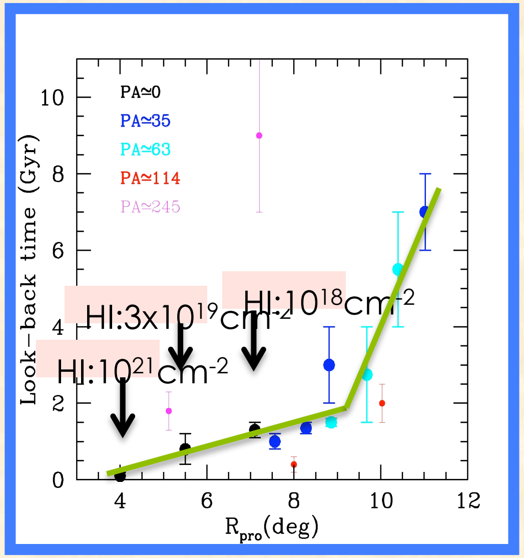
The SFH changes as a function of radius in dwarf galaxies and in the Magellanic Clouds, with stellar populations younger on average toward the central parts.







Dwarf galaxy profiles remain exponential over time, with decreasing α toward the present time



Outside-in quenching of the current LMC star formation activity, at a rate of ≈ 3 Kpc/Gyr, out of ≈9°. Faster quenching al R>9°