Galaxy Archaeology of M81 group

Sakurako Okamoto
Shanghai Astronomical Observatory

N. Arimoto (NAOJ), A. Ferguson (Edinburgh), M. Irwin (Cambridge)
E. Bernard (OCA), Y. Yamada (NAOJ), U. Utsumi (Hiroshima)
DM densities of MW-like galaxy halos

Stars formed in satellites of MW-like galaxies

Springel+2008

Cooper+2010
Resolved Stellar Photometry of Galaxies

- Reach well below the sky level
- Direct proof of faint (sub-)structures
- Better constraint of Age/Metallicity of individual stars
- Less foreground/background contaminations
- Less influence of foreground cirrus

- Limited number of target galaxies (< a few Mpc)
- Require both image depth and wide FoV

http://apod.nasa.gov/
M81; Near field cosmology beyond the LG with HSC/Subaru

M82
$M_V = -19.4$

M81
$M_V = -20.8$ (MW: -20.9)

NGC3077
$M_V = -17.2$
(LMC: -17.6)

HI distribution (Yun et al. 1994)

http://apod.nasa.gov/
M81; Near field cosmology beyond the LG with HSC/Subaru (S14A-184, S14B-101, S15B-073, S16A-096, S16B-011)

- True nature of young/old stellar contents in the large scale structures
- Age and metallicity constraints for the extended component
- New stellar debris, satellites, streams, arcs in the entire region
- Globular clusters in the M81 group

http://apod.nasa.gov/
M81; Near field cosmology beyond the LG with HSC/Subaru
M81 photometry
M81 photometry
Resolved stellar photometry

i-band (3.5x2.5 arcmin ~ 0.14% of HSC FoV, 0.06% of processed field)
Red giant branch stars of M81

Unresolved distant galaxies

$\left[Fe/H\right]=-0.75$

Age = 10, 18, 32, 50, 100, 160 Myr

$\left[Fe/H\right]=-2.2, -1.75, -1.3, -0.75$

Age = 12 Gyr

$<50 \text{ Myr}$

$25-160 \text{ Myr}$

$>1 \text{ Gyr}$

Okamoto+2015
Spatial distribution of each population

- HI (Yun+1994)
- MS (< 50 Myr)
- MS+cHeB
- RSG
- AGB
- RGB
- red objects
- blue objects
- >1 Gyr
- >1 Gyr
- contaminants

Okamoto+2015
Young stars (<100Myrs)

- Bright (younger)
- Faint

Old stars (>1Gyrs)

- Blue
- Red
  - (rich)
  - (poor)

Map (Yun et al. 1994)

Garland

AL

HoIX

BK3N

M81

M82

N3077

Okamoto+2015

HI map (Yun et al. 1994)
Young dwarf galaxies

Arp’s Loop  HoIX  BK3N  Garland

[g−I]_0  [g−I]_0  [g−I]_0  [g−I]_0

Δα [arcmin]  Δα [arcmin]  Δα [arcmin]  Δα [arcmin]

r=3′

(Okamoto+2016 in prep)
Young stars (<100Myrs)

Old stars (>1Gyrs)

[Fe/H] = -2.3

[Fe/H] = -0.75

[Fe/H] = -1.4

Okamoto+2015
Young stars (<100Myrs)

Old stars (>1Gyrs)

$\text{r} = 5 \times \text{R}_{25}$

$\text{r} = 2 \times \text{R}_{25}$
Dwarf galaxies and substructures in the observed field

(Okamoto+2016 in prep)
Old dwarf galaxies

(Okamoto+2016 in prep)
Very faint dwarf galaxies

(Okamoto+2016 in prep)
Summary

M81 galaxy archeology :
✧ Young intra-group pops follow the HI filamentary distributions.
✧ Young stars in numerous outlying stellar associations, which SF was synchronized each other (i.e. tidal dwarfs).
✧ Very extended (>>2*R_{25}) old stellar halos of M81, M82, NGC3077
✧ Highly disturbed morphologies of M82 and NGC3077 outer halos
✧ Bluer (more metal-poor) outer halo of M82

On-going works....
Analyses of halo profiles & individual dwarf galaxies, Exploration of new satellitesstreams/substructures, Data processing, Photometry, Observations, Follow-up proposals, papers...