The Panchromatic Hubble Andromeda Treasury
Why HST+M31?

- Millions of stars at a common distance, with known environments
- Rich existing catalogs & coverage
- Wide range of [Fe/H], reaching super-solar

Add a high metallicity, massive galaxy anchor to LMC/SMC
Ground

HST (ACS)
Multi-cycle HST Tiling of M31

- 828 orbits, 4 years
- 6 Filters (UV-NIR)

GALEX
PHAT Filter Set

Filters

Spectra of Stars

Transmission

$F_{\lambda}$

$\lambda(\text{Å})$

$10^4$

F475W  F814W

G7III
Observing Strategy (3x6 “Bricks”)

F275W  F336W  F475W  F814W  F110W  F160W

\[ \lambda (\text{Å}) \]

\[ S_\lambda \]

\[ F_\lambda \]

Vega  Sun  M5III
WFC3/IR + WFC3/UVIS

1.5 kpc x 3.0 kpc at M31

ACS

180° flip (6 Months)

ACS

WFC3/IR + WFC3/UVIS
~90,000,000 stars, multiple properties measured at up to 17 different times

>30% of the number of stars in SDSS
Depth varies with Radius

Crowding limited in NIR & optical

- F160W
- F110W
- F814W
- F475W
Extensive DEIMOS Spectroscopy

Claire Dorman
Raja Guhathakurta
Jason Kalirai
Kirsten Howley

Phase I (complete!):
Primarily AGB/RGB
A few X-Ray Counterparts
A few Candidate PNe

Phase II Targets:
Hot stars (spectral typing)
X-ray, QSO, PNe

See Talks at this meeting

Other supporting spectroscopy:
Skillman, Berg, & Kirby (HII region abundances)
Caldwell (stellar clusters and PNe)
See Poster by Hui Dong on dust
Brick 15
Brick 21
Like looking at the Empire State Building, but being able to resolve a human hair
NIR CMDs

Brick 1

F110W - F160W

Brick 9

F110W - F160W
RGB Doubling Due to Dust
Subregions of single WFC3/IR frame

Unreddened peak

Reddened peak

Foreground stars

Background stars
Individual RGB stars color coded by reddening
3x3 WFC3/IR

Brick 9

E(B-V) Mapping

Brick 15

E(B-V) Mapping

24µm

CO

24µm
Stars

Connecting major baryonic phases: Stars + Dust + Gas

Dust (from HST IR)

Molecular Gas

See Talks by Sandstrom and Schruba, Poster by Kapala
UV: less crowding, more CRs, lots of main sequence stars

UVIS Brick 9
Stars in the Bulge are Odd

Saglia et al 2010; Lick Indices

Super-Solar
Solar
M30 M60 MN
P30 P60

1. UV
2. Optical+NIR

Saglia et al 2010; Lick Indices
Extreme Horizontal Branch (HB) Stars

T_{\text{eff}} > 10^4 \text{K}

23 Globular Clusters observed with GALEX (Schiavon et al 2012)

“Horizontal” Branch

White Dwarfs


GALEX (M31)

b): Core He-burning, after RGB
UV Bright Stars in the Bulge
Phil Rosenfield et al, 2012

F275W
F336W
F475W
F814W

61 parsecs  16″
Can Detect Hot HB Descendants

- Brighter than HB
- Faster evolution, so rarer and less crowded

Origin? Lost envelope on RGB
Strong radial variation in fraction of hot stars with high RGB mass loss.

% of Stars becoming Hot Post-HB

Metallicity

Percentage of HP-HB

Log Radius (pc)

Metallicity from Saglia et al 2010

Lick Indices

Phil Rosenfield, et al 2012
Affects other phases that are important in the optical and IR!

- Numbers & luminosity function of IR-bright AGB
- Gas return through RGB winds
FUV-NUV color tracks metallicity

Production of Extreme Horizontal Branch linked to bulge metallicity
Summary

Tons of Stars = Tons of Science