

Galaxy Assembly in the Local Volume

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In the Galaxy Evolution document, Betsy Gillespie asks:

- When and where did stars form?
- When and where did the elements form and where did they go?

We seek to answer these questions through observations of nearby galaxies, to complement studies at high redshift

Strengths:

- Measure entire star formation and chemical enrichment histories for single galaxies
- Can measure critical parameters such as the IMF

Weaknesses:

- Kinematics are partially or entirely scrambled
- Ages less precise for oldest stars

Goals for the 30-m

- Measure the ages and abundances of the dominant stellar populations in spiral bulges, spiral disks, and portions of elliptical galaxies

What is the relationship between bulge and disk formation?

Can we detect the merger history of elliptical galaxies?

- Measure the ages and abundances of extragalactic globular clusters

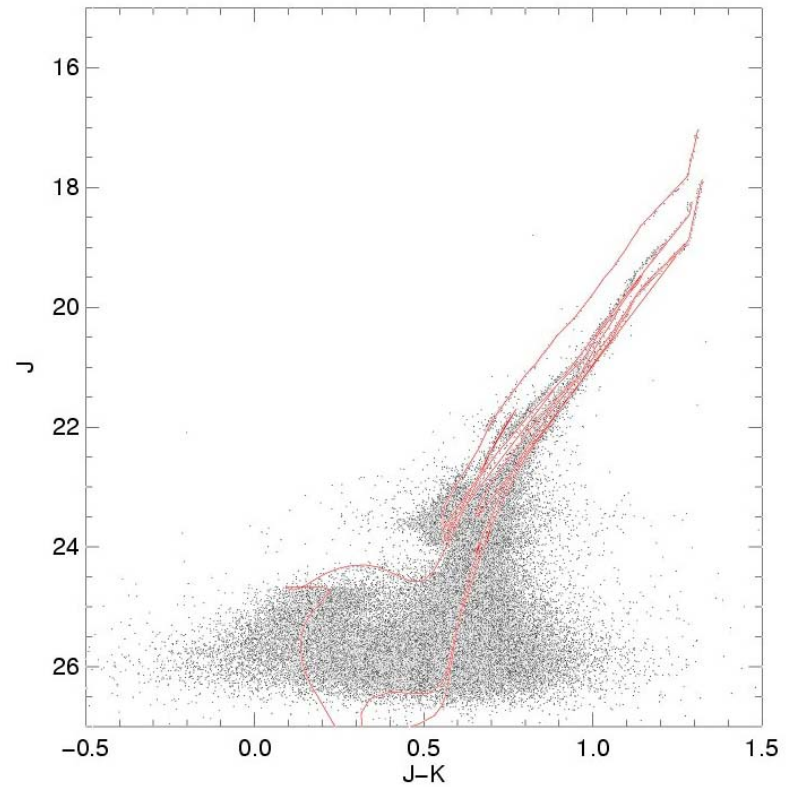
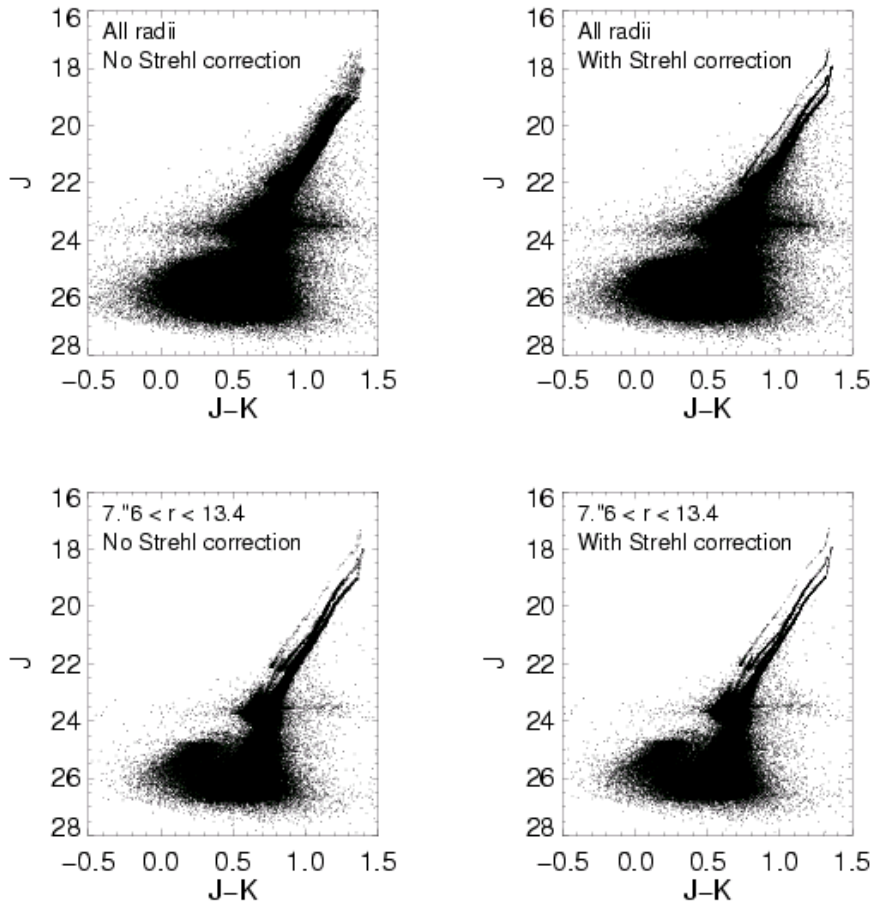
Was there a universal globular cluster formation epoch?

What is the assembly history of globular cluster systems?

A Progress Report

- Photometry with variable-Strehl MCAO PSFs
- Simulated photometry of M31 bulge, NGC 3379 (R_e), M31 globular cluster, and Virgo globular cluster
- From CMDs, carried through analysis of star formation and chemical enrichment histories and globular cluster properties

Photometry with variable Strehl



PSFs from Brent Ellerbroek

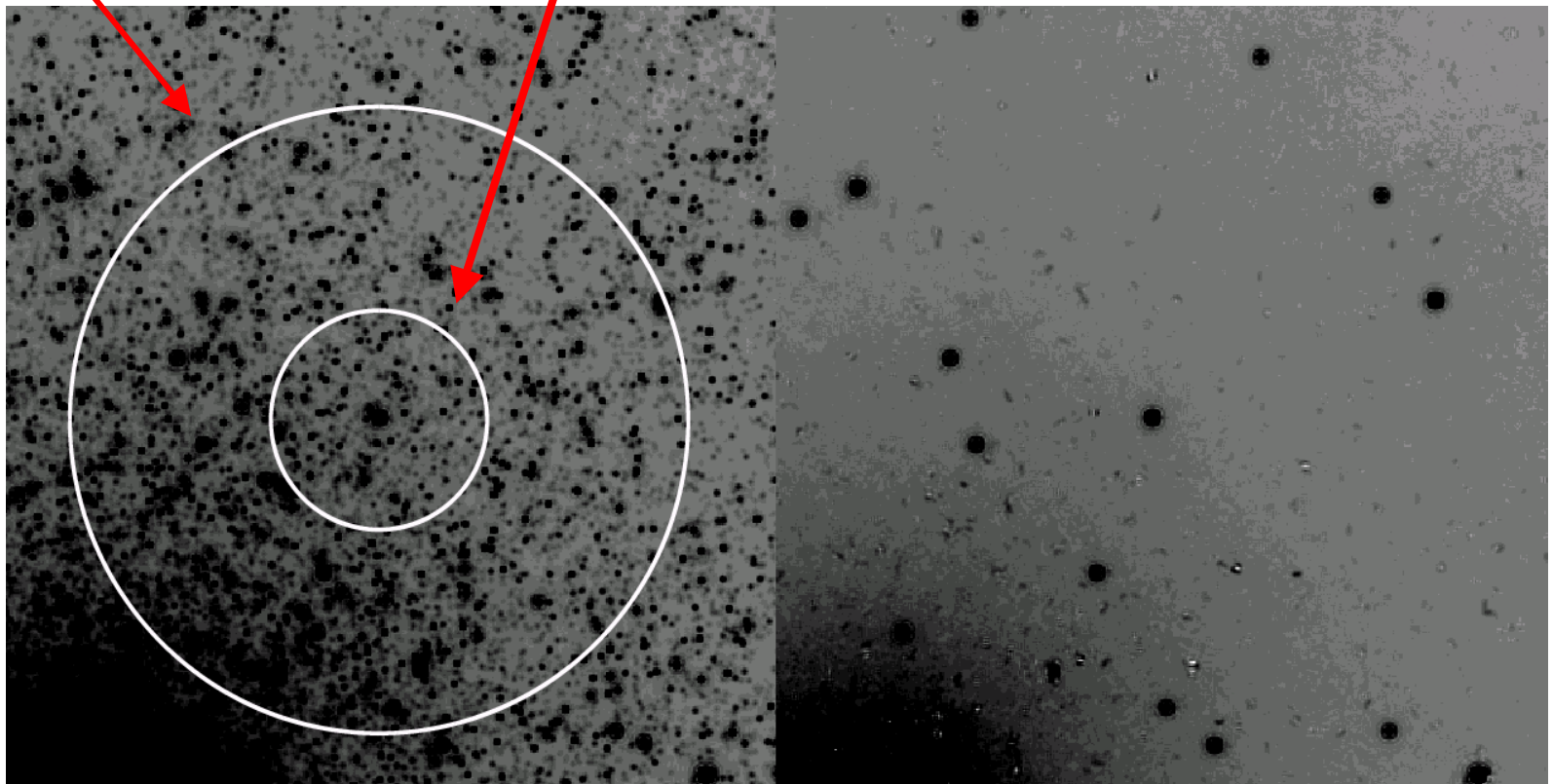
Uniform Strehl

80 - 85% Strehl in K, 50 - 62% in J

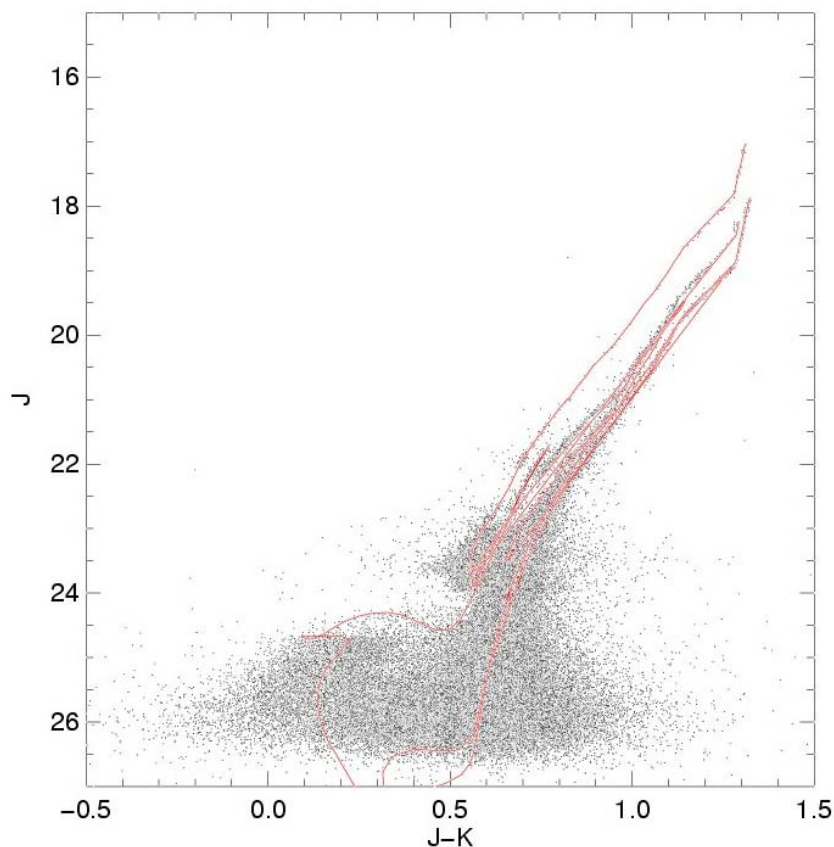
Why aperture corrections are difficult

Radius for 5% *absolute* photometry

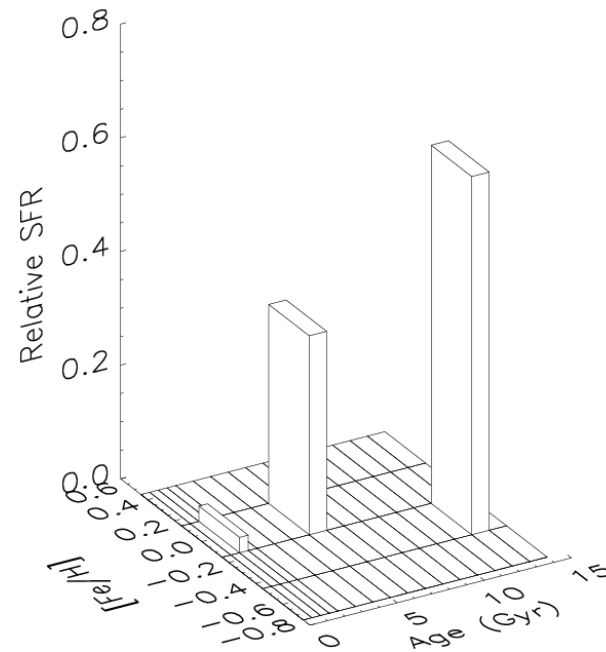
Radius for 2% *relative* photometry



Measuring star formation and chemical enrichment histories



Uniform Strehl photometry

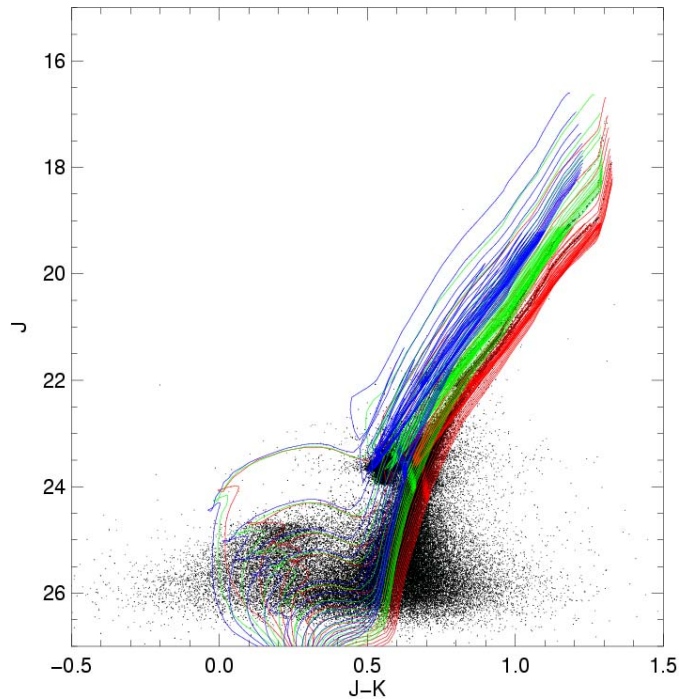


3% 1 Gyr/[Fe/H]=0.0

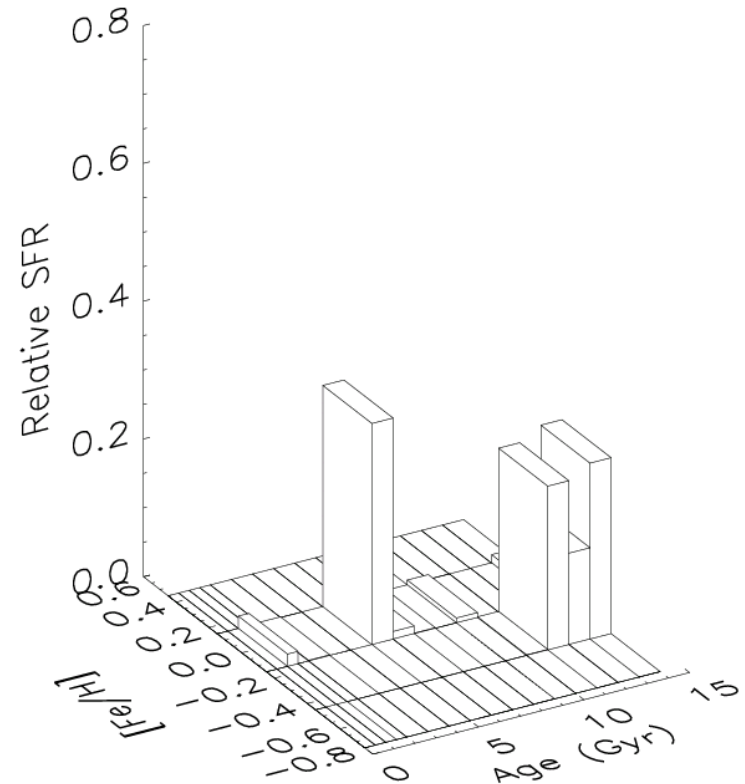
35% 5 Gyr/[Fe/H]=0.0

62% 10 Gyr/[Fe/H]=-0.3

Results

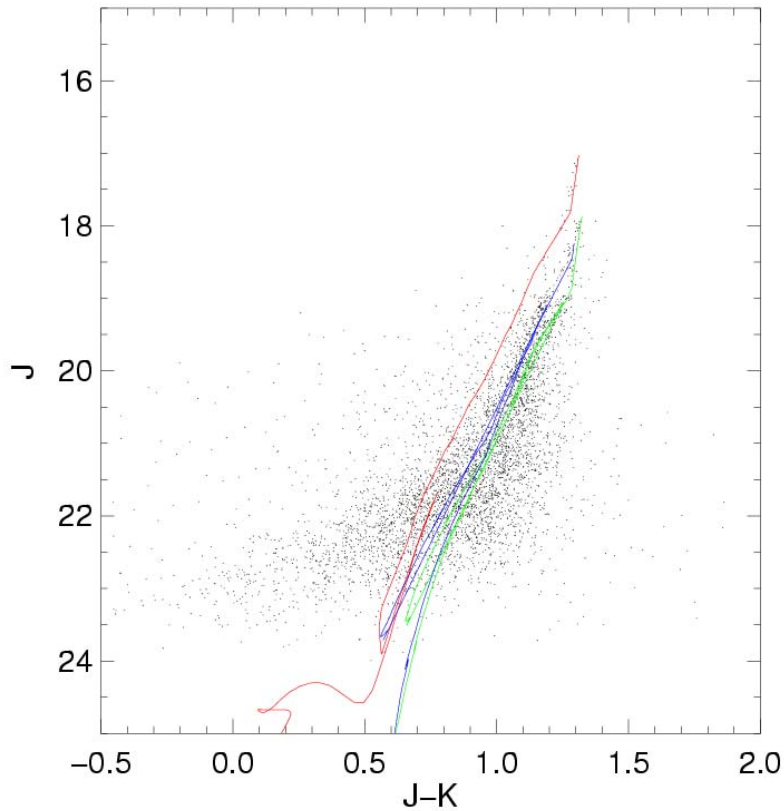


- Maximum likelihood method of Dolphin (1997)
- 45 model isochrones with ages from 0.5 - 13 Gyr and $[\text{Fe}/\text{H}] = 0.0, -0.3, -0.6$ compared with data
- Analytical photometric errors from Olsen, Blum, & Rigaut (2003; astro-ph/0304163)

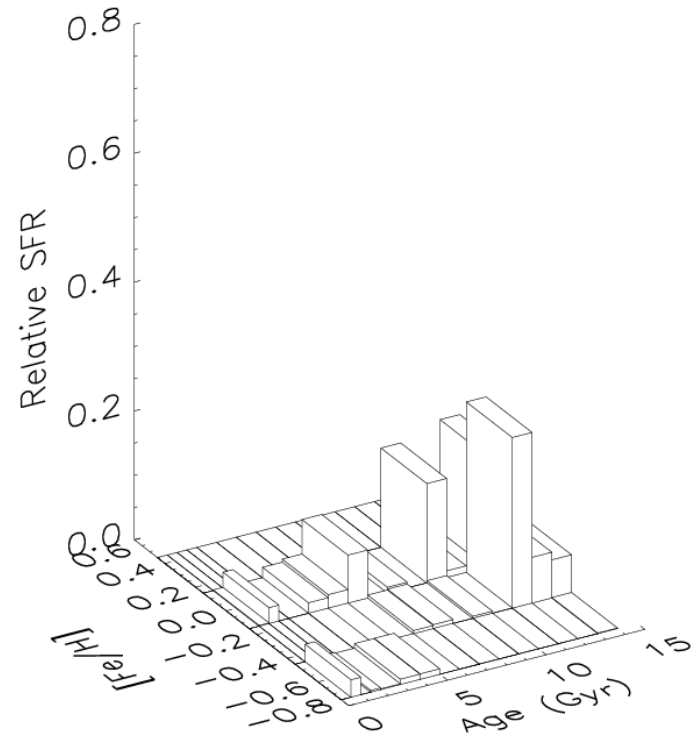


- 2% 1 Gyr/ $[\text{Fe}/\text{H}] = 0.0$
- 34% 5 Gyr/ $[\text{Fe}/\text{H}] = 0.0$
- 64% 10 \pm 1 Gyr/ $[\text{Fe}/\text{H}] = -0.3$

30-m vs. 8-m



8-m NGST

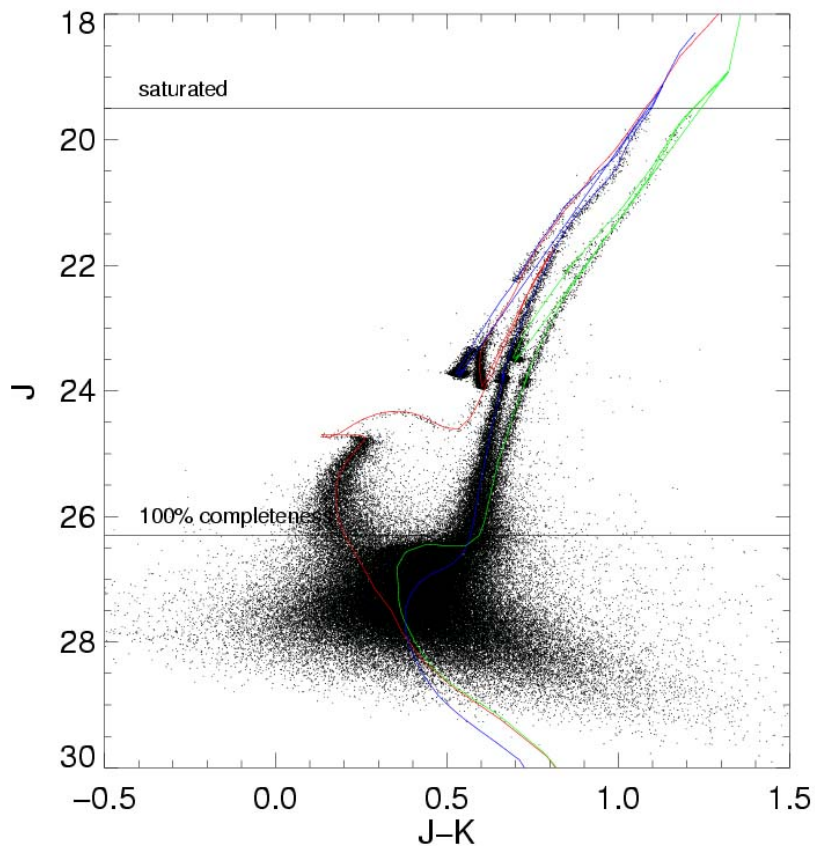


5% 0.5--1 Gyr/[Fe/H]= -0.6 -- 0.0

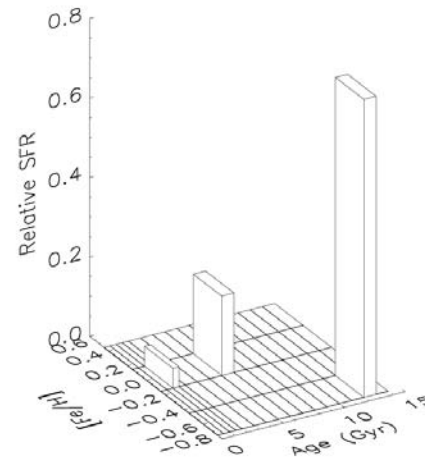
15% 3--7 Gyr/[Fe/H]=0.0

80% 9--13 Gyr/[Fe/H]=-0.3 -- 0.0

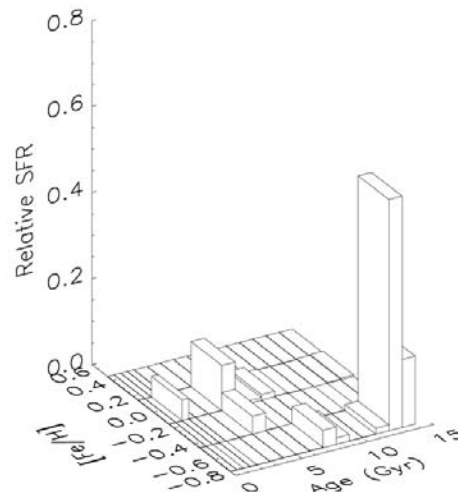
The Bulge of M31



5% 1 Gyr/[Fe/H]=0.0
 20% 5 Gyr/[Fe/H]=0.0
 75% 12 Gyr/[Fe/H]= -0.6

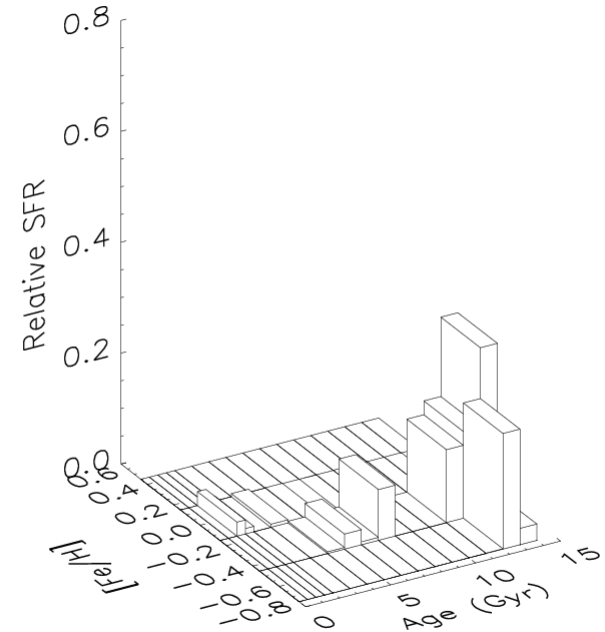
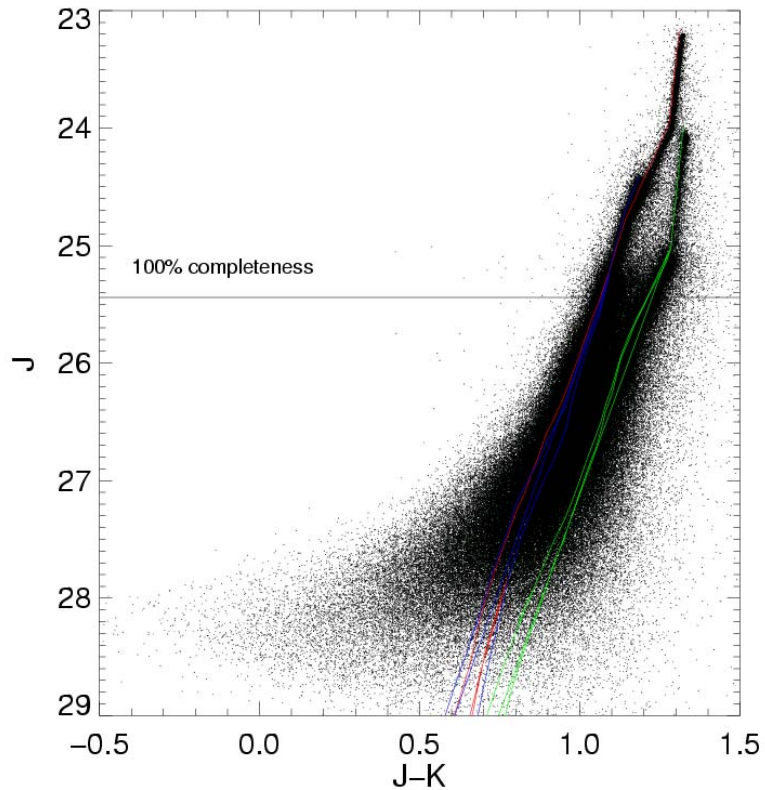


5% 1 Gyr/[Fe/H]=0.0
 15% 4 Gyr/[Fe/H]=-0.3 -- 0.0
 5% 7 Gyr/[Fe/H]=-0.6
 75% 12+/-1 Gyr/[Fe/H]= -0.6



Includes differential reddening

The Effective radius of NGC 3379



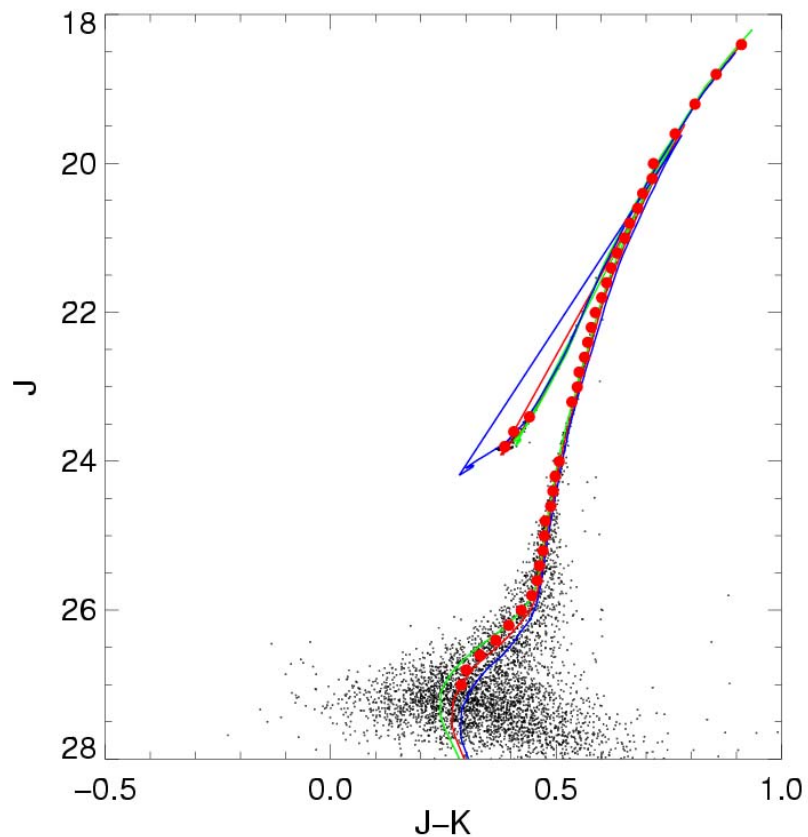
4% 1 ± 0.5 Gyr/ $[Fe/H]=0.0$

12% 5--7 Gyr/ $[Fe/H]=-0.3$

84% 12 \pm 1 Gyr/ $[Fe/H]= -0.6 \text{ -- } -0.3$

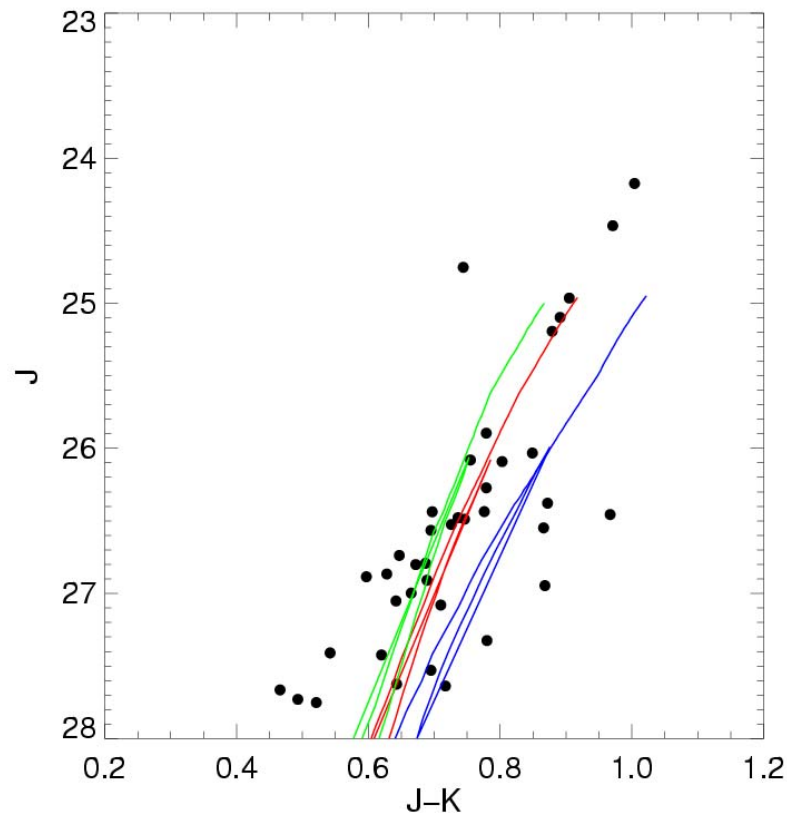
Globular clusters in M31 and Virgo

$m-M = 24.3$



Age = 12 ± 2 Gyr, $[\text{Fe}/\text{H}]$ from spectroscopy

$m-M = 30.9$



$[\text{Fe}/\text{H}] = -1.5 \pm 0.3$

Summary

- We have assumed that Strehl prediction will provide 1 - 2% photometric accuracy for bright stars
- Analysis of CMDs show that the GSMT will produce star formation and chemical enrichment histories accurate to a few percent with ~ 1 Gyr and < 0.3 dex age and metallicity precision within the Local Group
- Out to distances approaching the Virgo cluster, the accuracy of star formation rates, ages, and metallicities are drop by a factor of ~ 2
- Local Group globular clusters will be easily studied by GSMT. Only the tip of the red giant branch will be visible in the Virgo cluster, but this will be enough to distinguish bimodal populations

Achievable depths set by crowding: 30-m

	M31 disk	M31 bulge	M31 globular cluster (5 R _c)	M87 center	M87 effective radius	M87 2 effective radii	Virgo dIrr	Virgo globular cluster (5 R _c)
Σ_K	19	17	19	13	18	20	19	19
M_K	2.4	0.8	2.2	-9.4	-6.4	-4.0	-5.0	-5.4
Exposure time	2200	120	1500	1	44	3200	510	250

Achievable depths set by crowding: 20-m

	M31 disk	M31 bulge	M31 globular cluster (5 R _c)	M87 center	M87 effective radius	M87 2 effective radii	Virgo dIrr	Virgo globular cluster (5 R _c)
Σ_K	19	17	19	13	18	20	19	19
M_K	1.6	-1.6	1.6	-10.0	-7.4	-5.2	-6.2	-6.4
Exposure time	2700	10	2700	1	37	1800	300	2500

Achievable depths set by crowding: 8-m

	M31 disk	M31 bulge	M31 globular cluster (5 R _c)	M87 center	M87 effective radius	M87 2 effective radii	Virgo dIrr	Virgo globular cluster (5 R _c)
Σ_K	19	17	19	13	18	20	19	19
M_K	-1.6	-3.2	-1.4	-10.0	-8.4	-7.4	-8.6	-7.8
Exposure time	300	20	420	15	204	1200	140	600