The Classification and Analysis of Distinct X-ray Binary Populations in M81

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ABINGOS

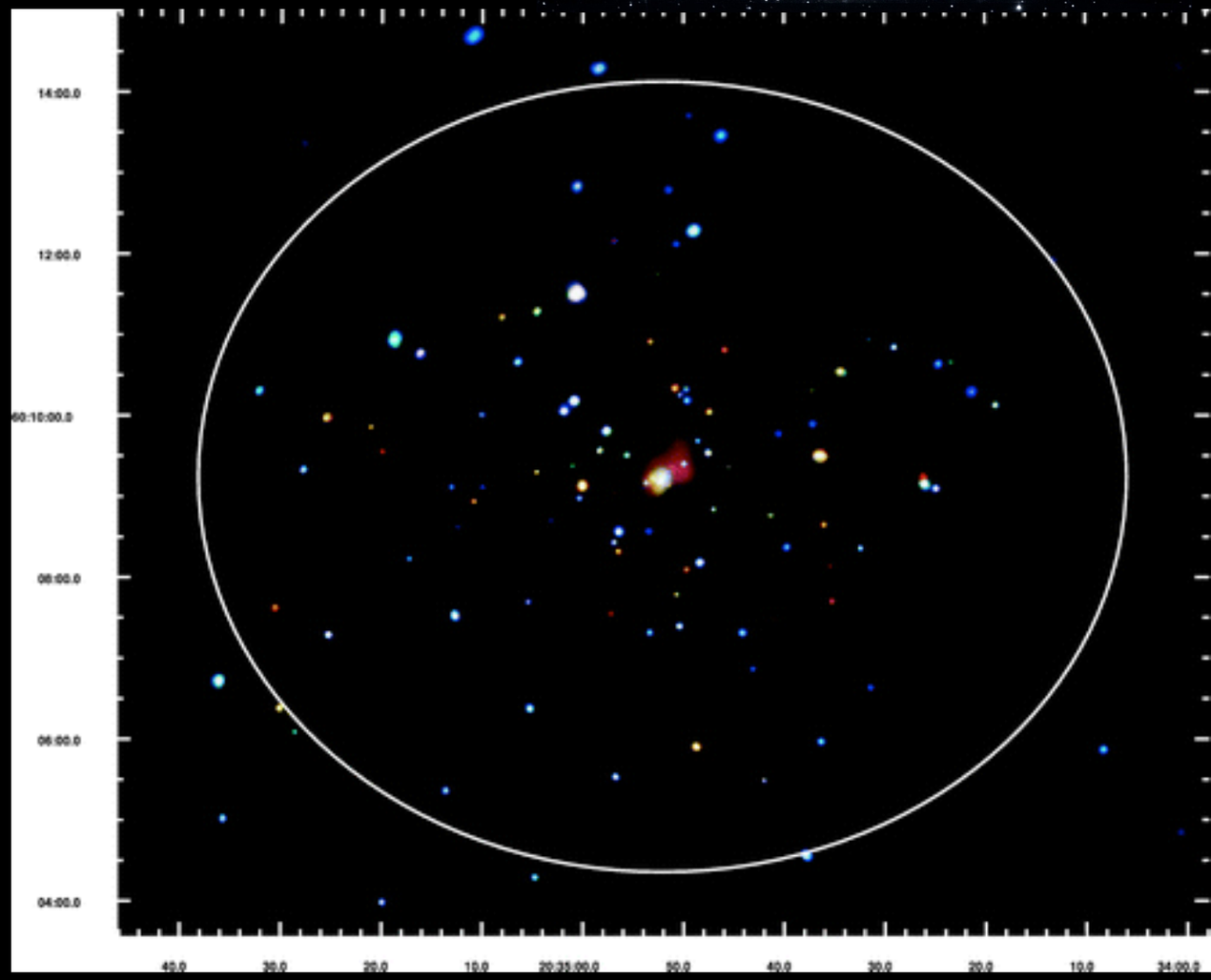
Accreting Binaries in Nearby Galaxies: Observations and Simulations

Nearby Galaxies in X-rays

M31 Bulge

Kong et al. 2003

NGC 6946

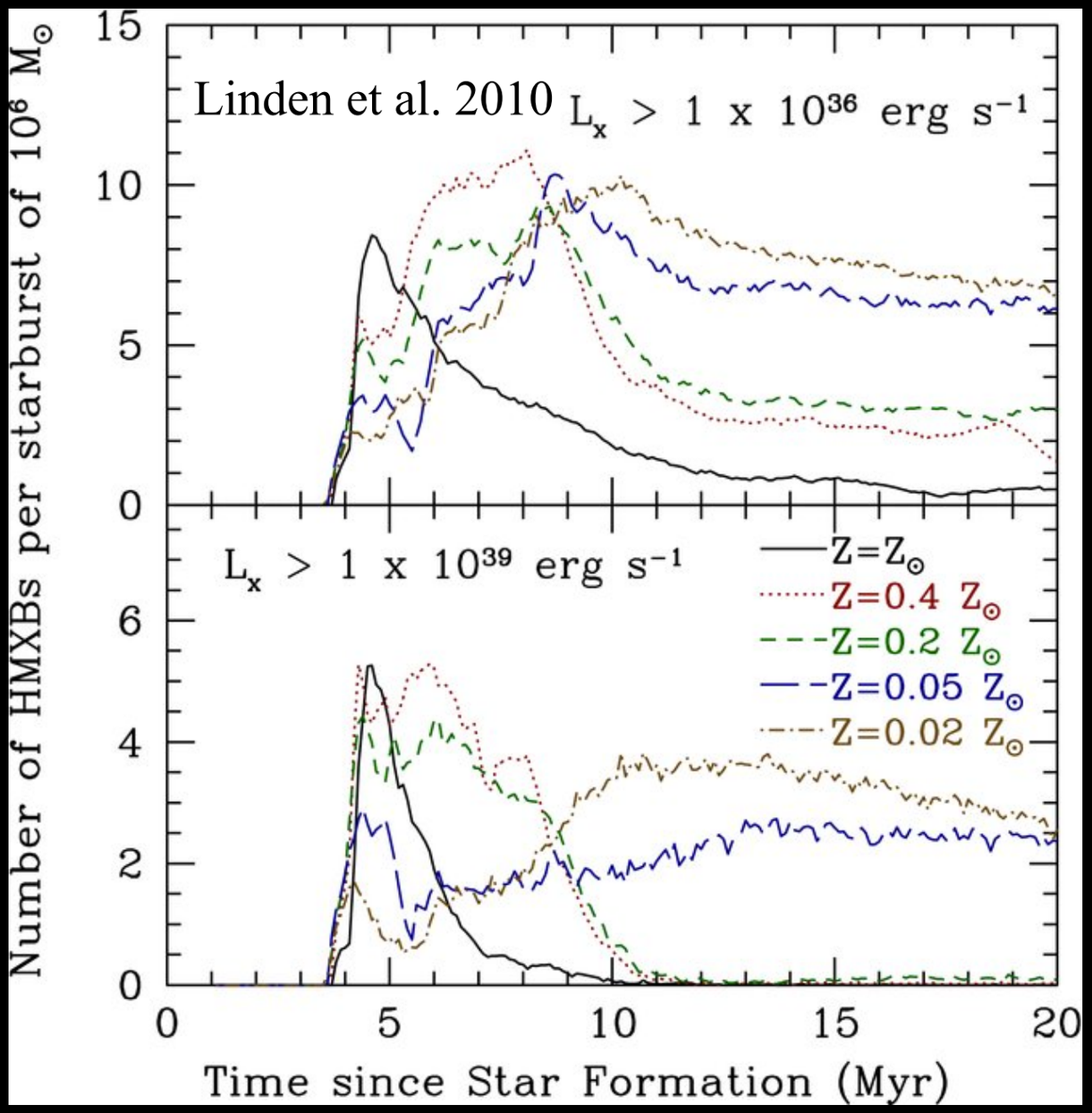


Fridriksson et al. 2008

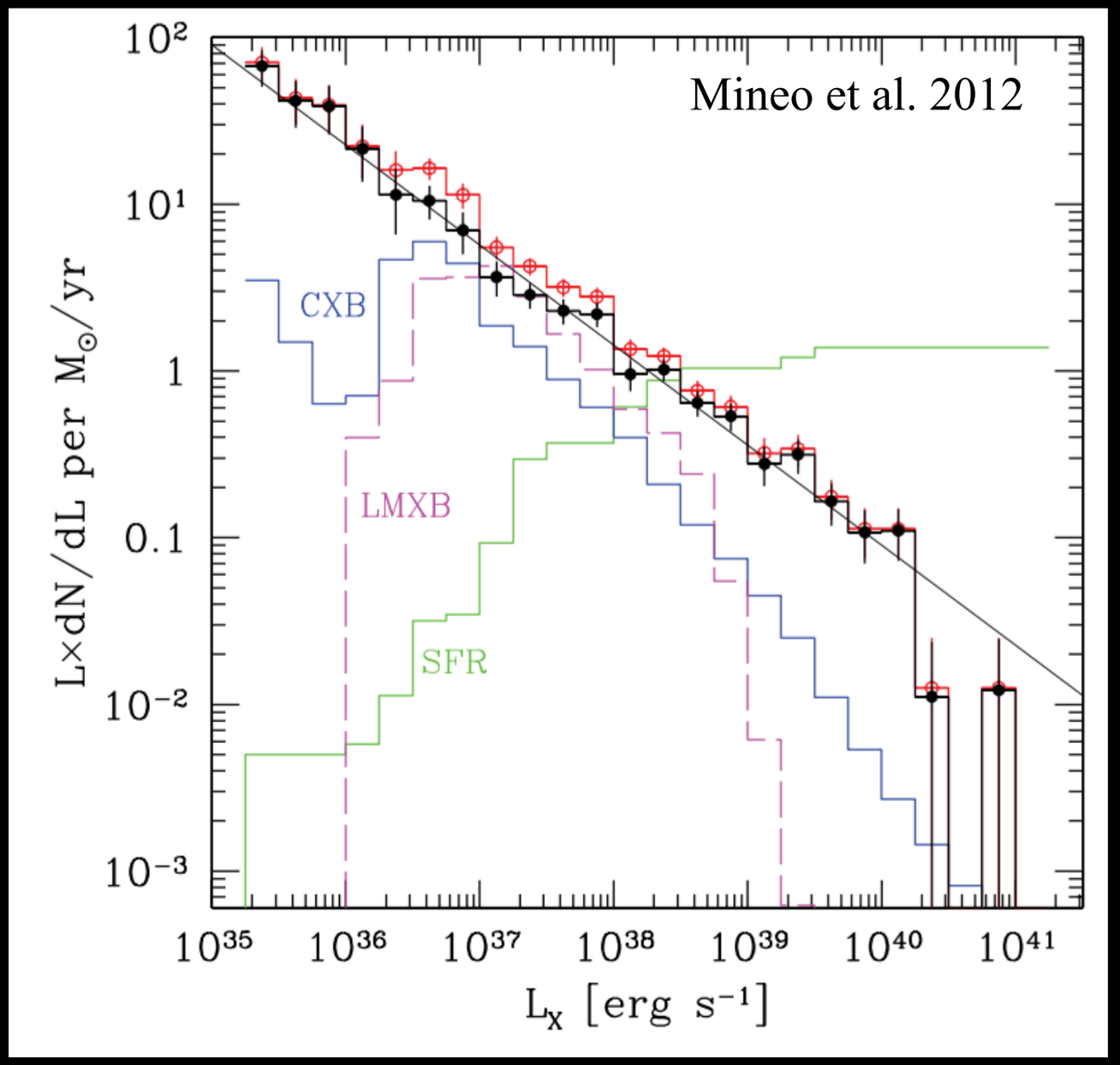
- What are these point sources?
- What is their luminosity/color distribution?
- How are they affected by metallicity, age…?
- Are they consistent with population synthesis models?

Motivation

Population synthesis with metallicity and age



High-mass X-ray binary luminosity function

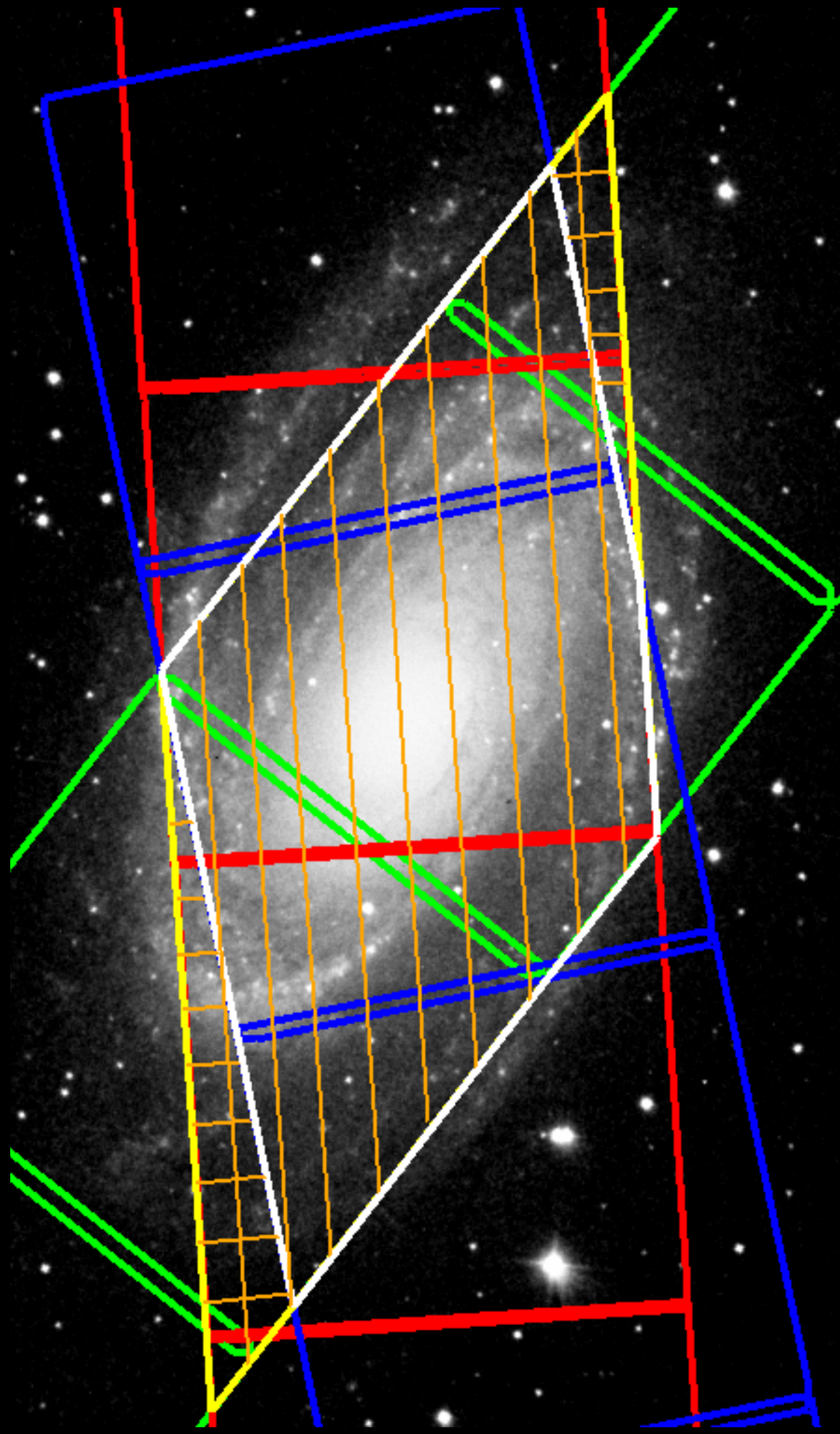


"Apparently [the LMXB prediction] grossly overestimates the LMXB numbers, therefore no attempt to subtract their contribution was made." ?!

M81

A Good Match for Chandra

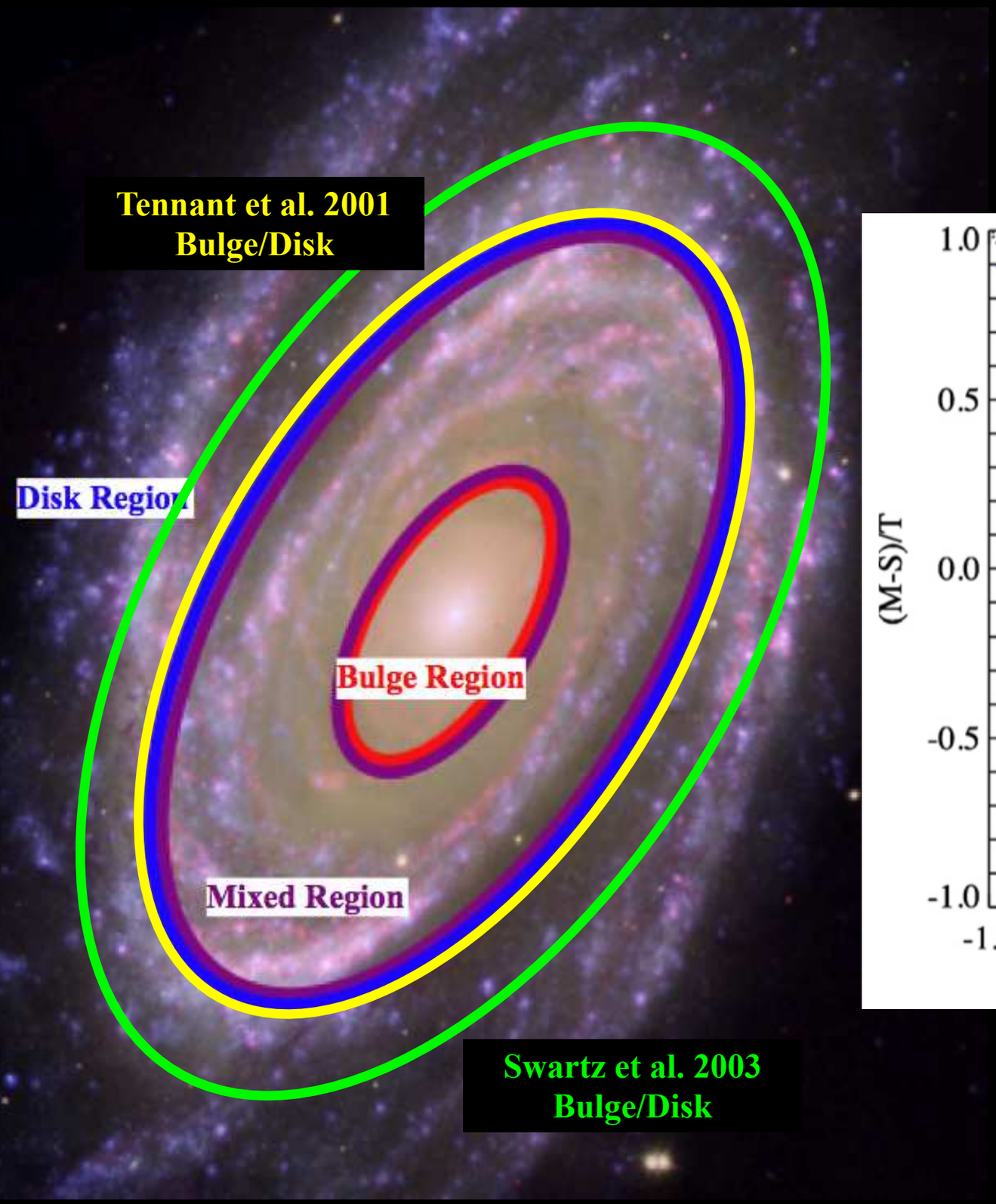
- Nearby: 3.63 ± 0.34 Mpc
- Angular size matches Chandra FOV well

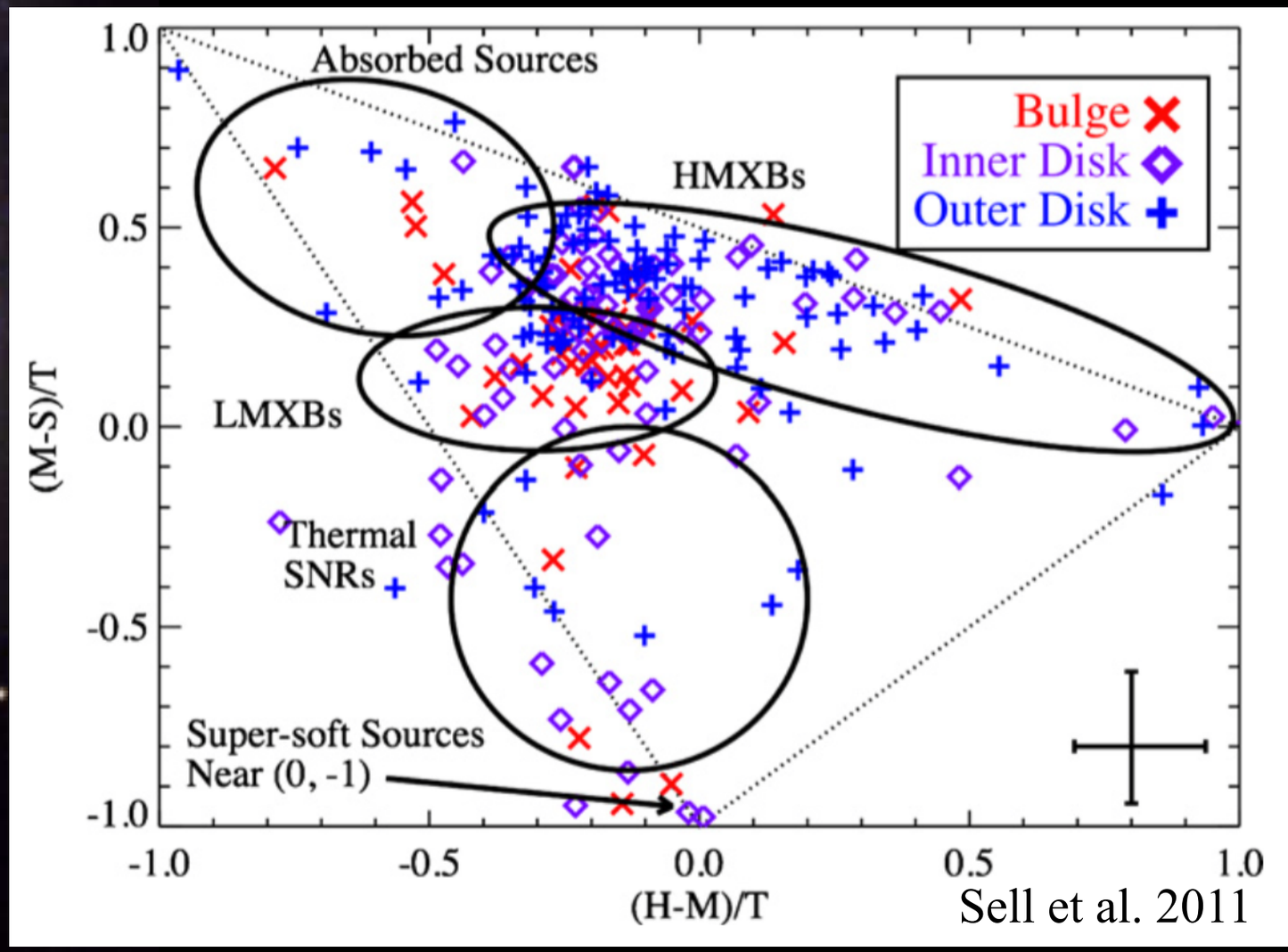


Observations:

- Fifteen 11-ksec observations (May 26 - July 6, 2005) at ~3-day intervals
- $L_X \gtrsim 2 \times 10^{36}$ erg/s (merged)
- One 50-ksec observation from May 7, 2000 (Swartz et al. 2003)
- 265 known point sources (Sell et al. 2011)

Previous Work on M81 XRB Populations

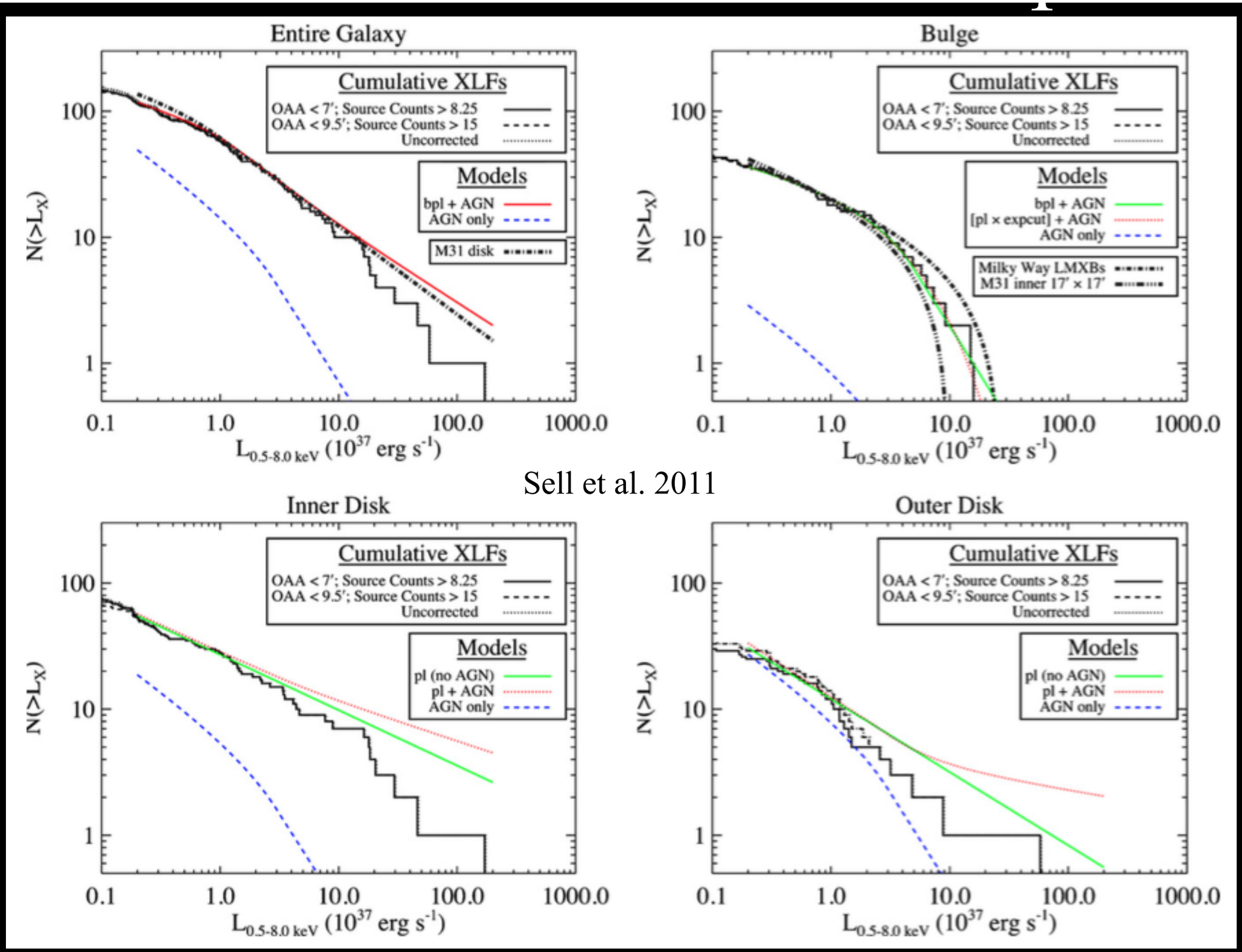




Sell et al. 2011

Based on Prestwich et al. 2003

Previous Work on M81 XRB Populations

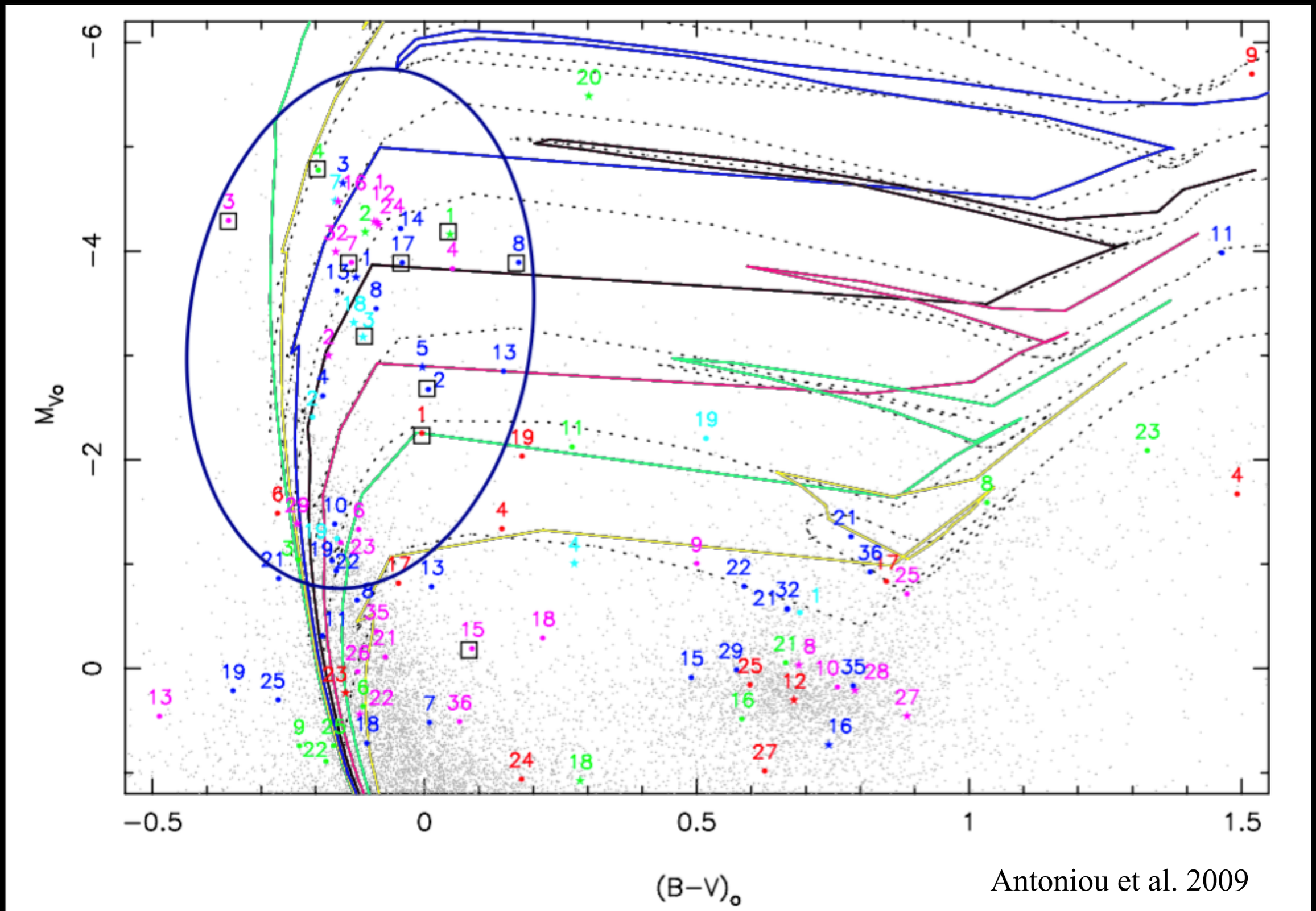


Sell et al. 2011

What do these results look like when we have individual source classifications?

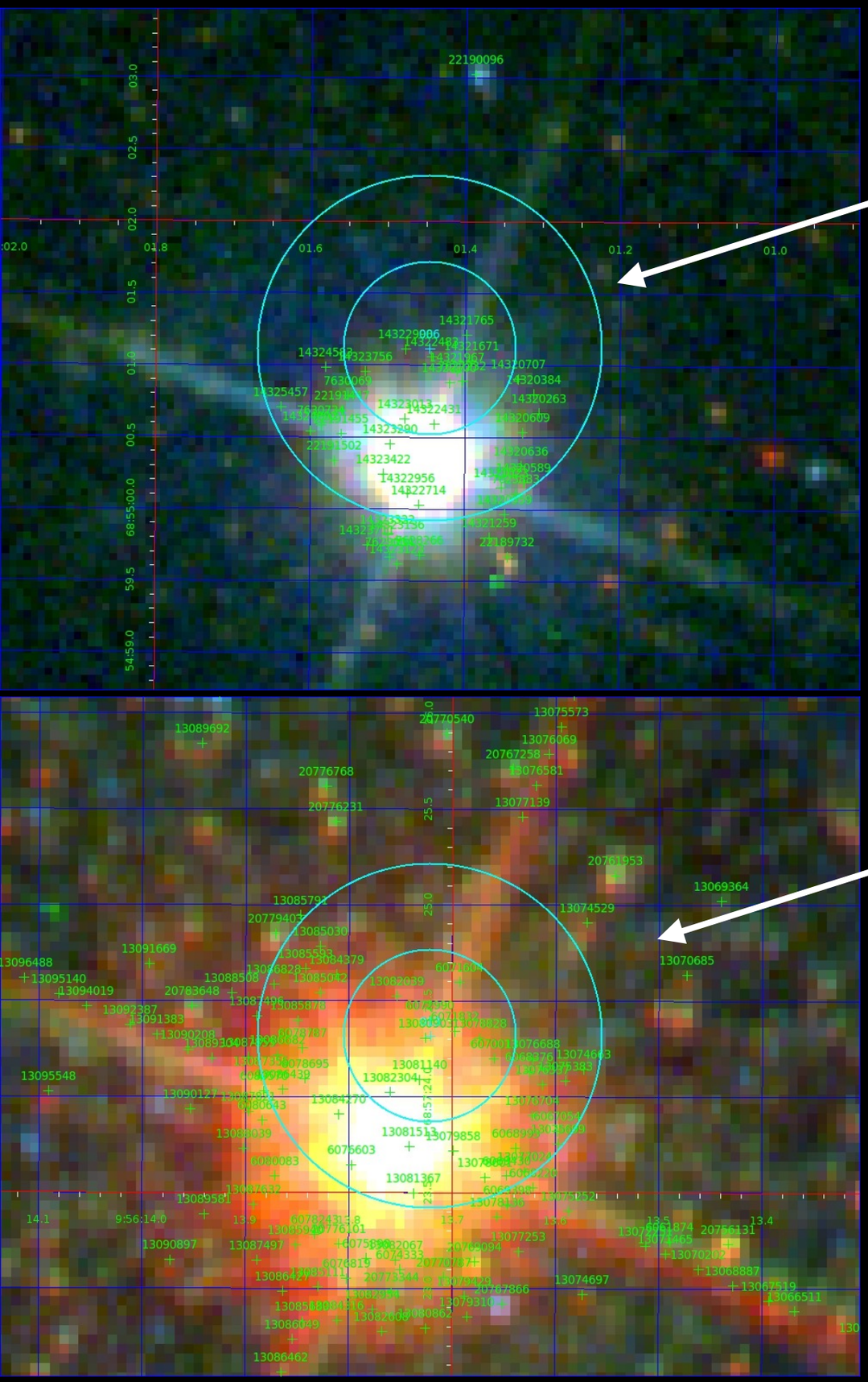
Source Classifications

Example: SMC Bar



Antoniou et al. 2009

Source Classification in M81–by eye

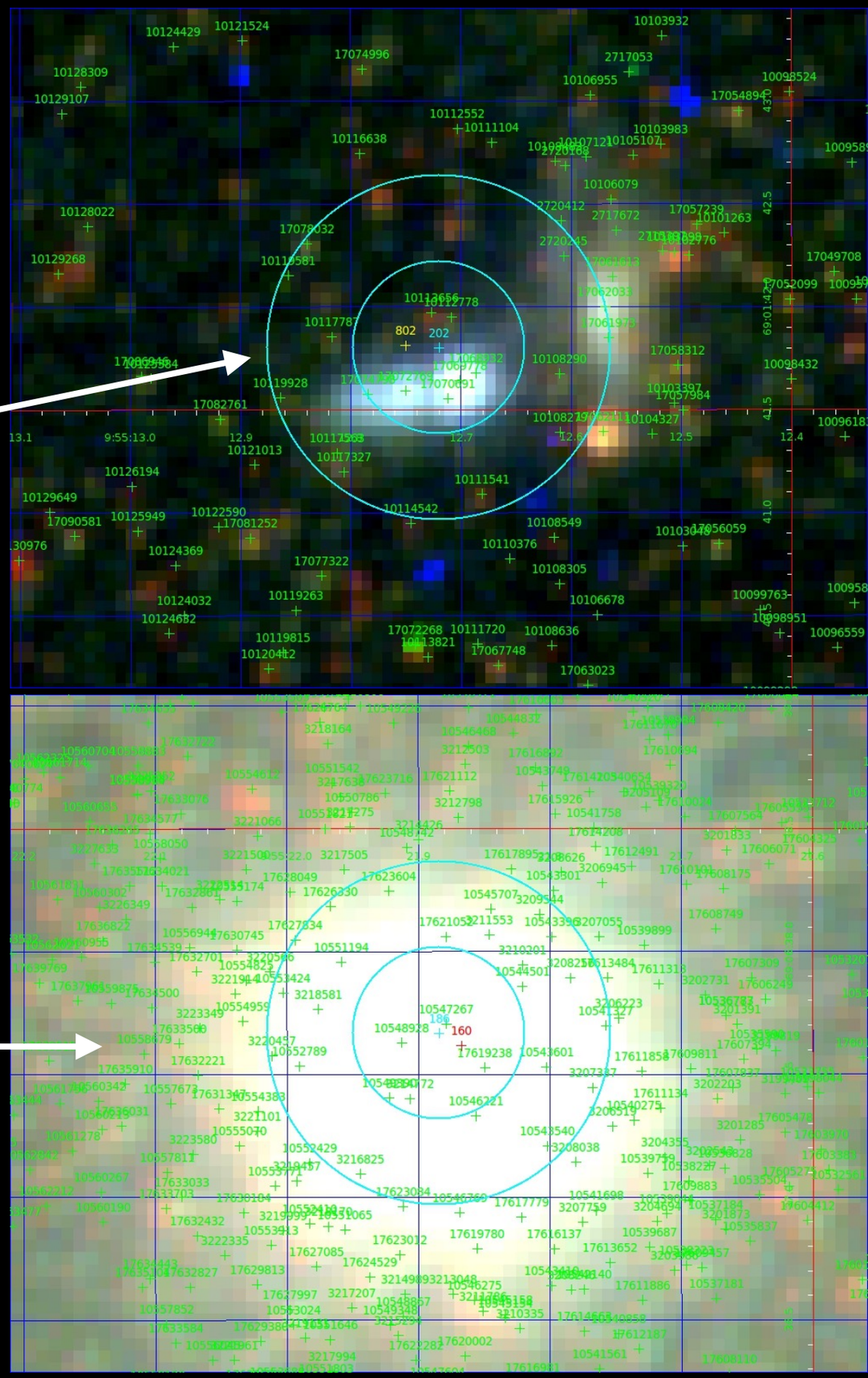


Background Quasar
(2XMMi J095701+685500)

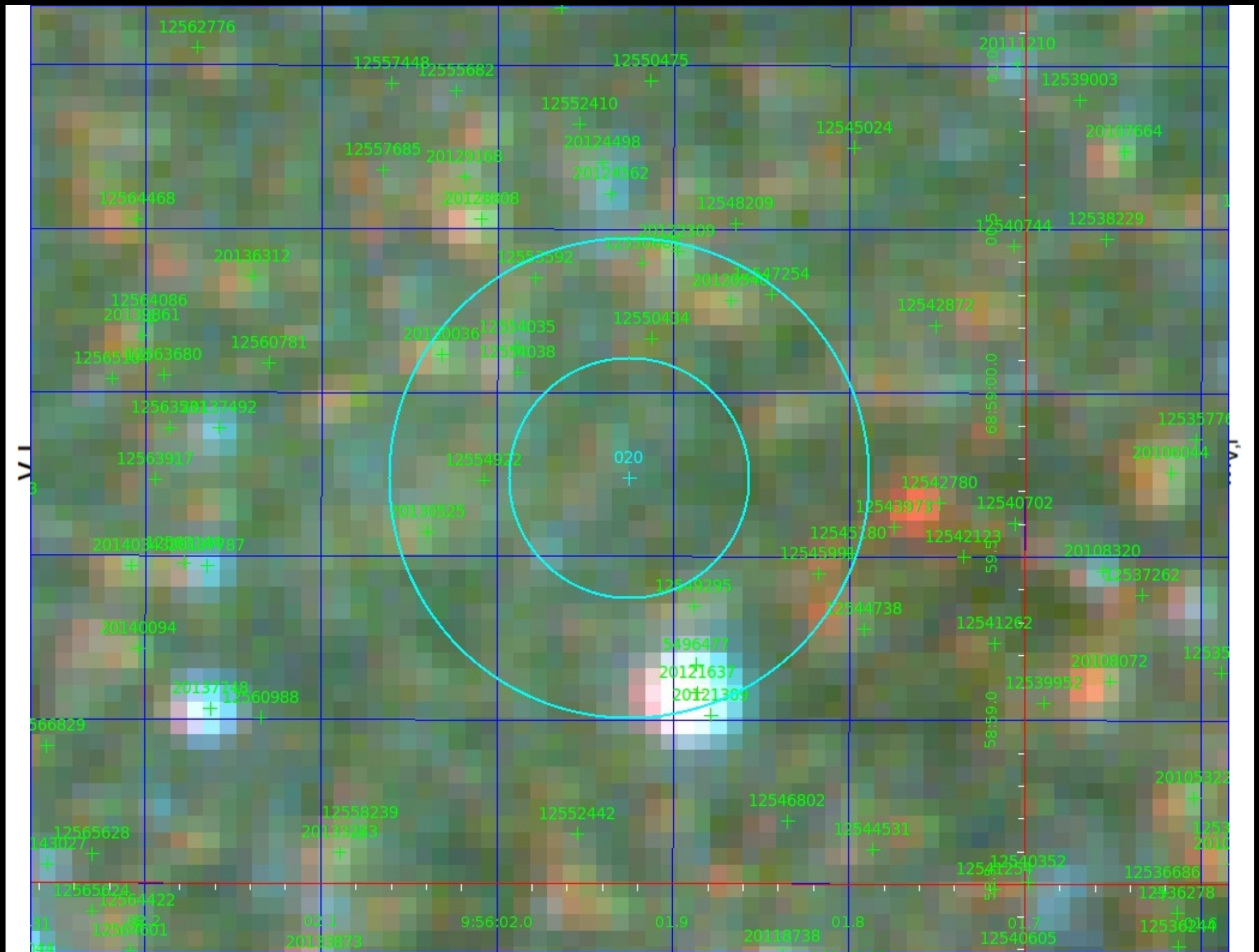
Background Galaxy

Foreground Star

Globular Cluster



Source Classification in M81–CMD

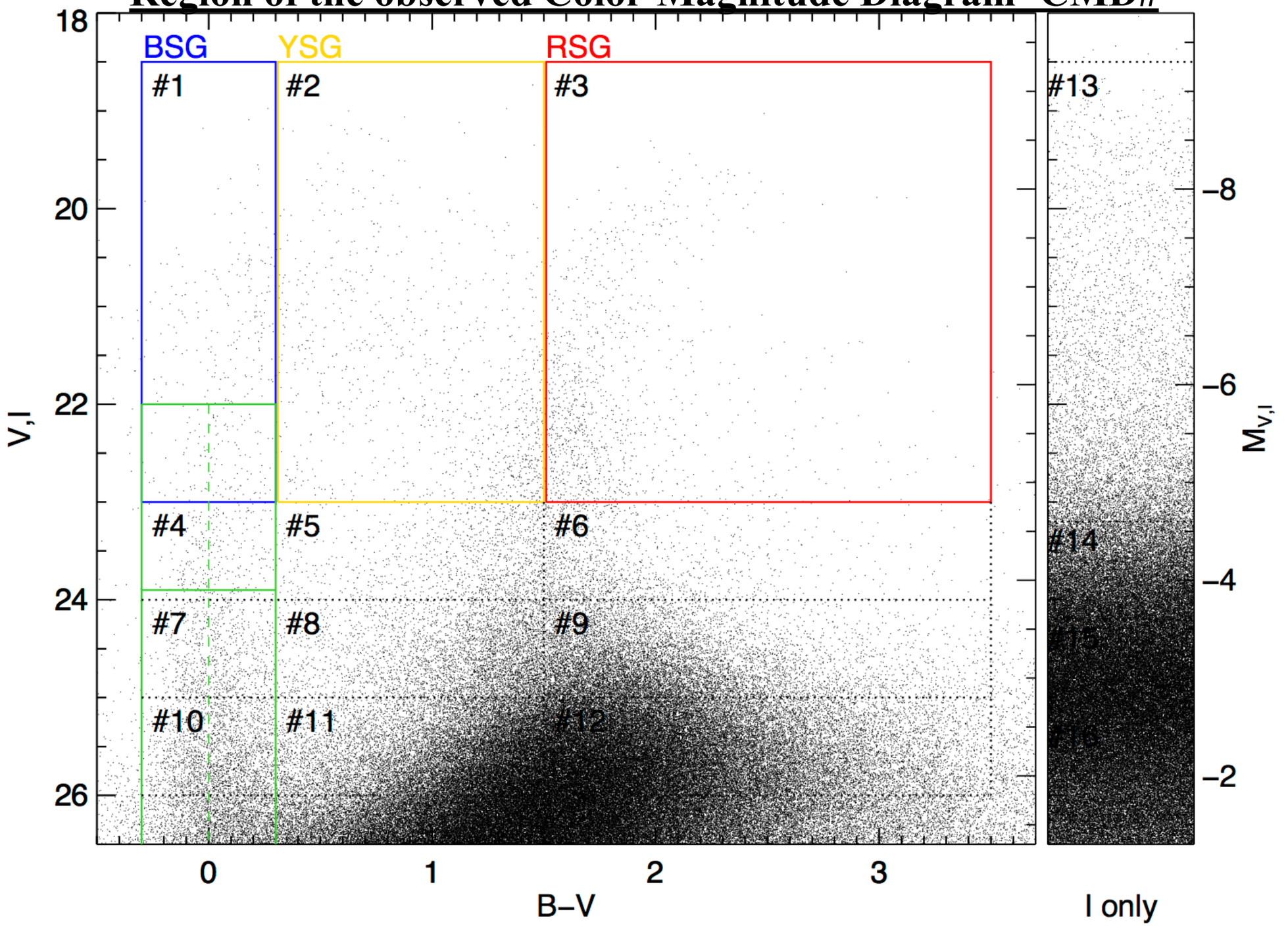


Chance Coincidence Probability (CCP)

"the probability that an HST source is randomly associated with a Chandra source"
= # of Chandra sources matched after random shifts / # of Chandra sources matched without shifting

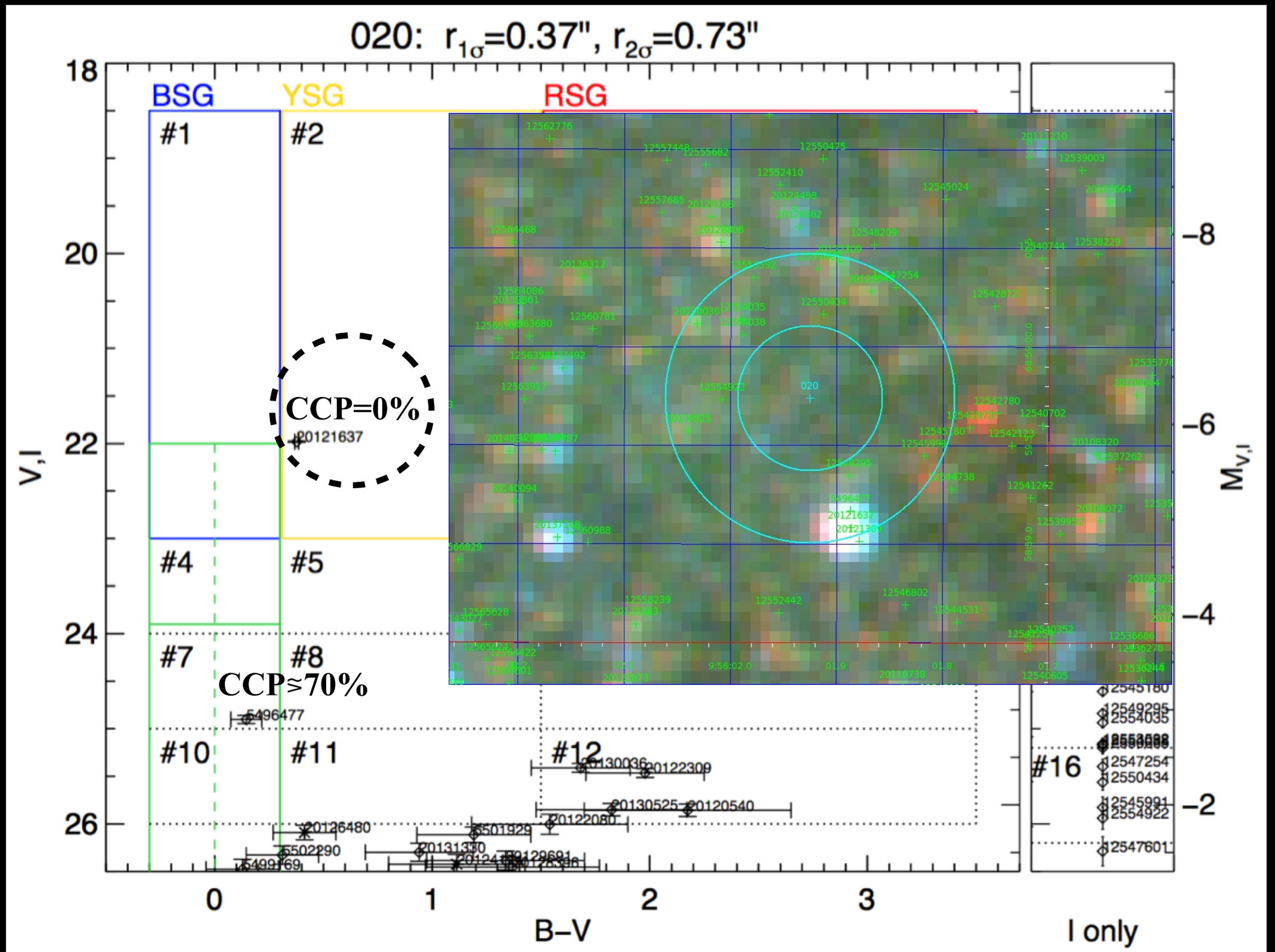
CCP = CCP(CMD#,$\rho_\star$,r_s)

Region of the observed Color-Magnitude Diagram=CMD#



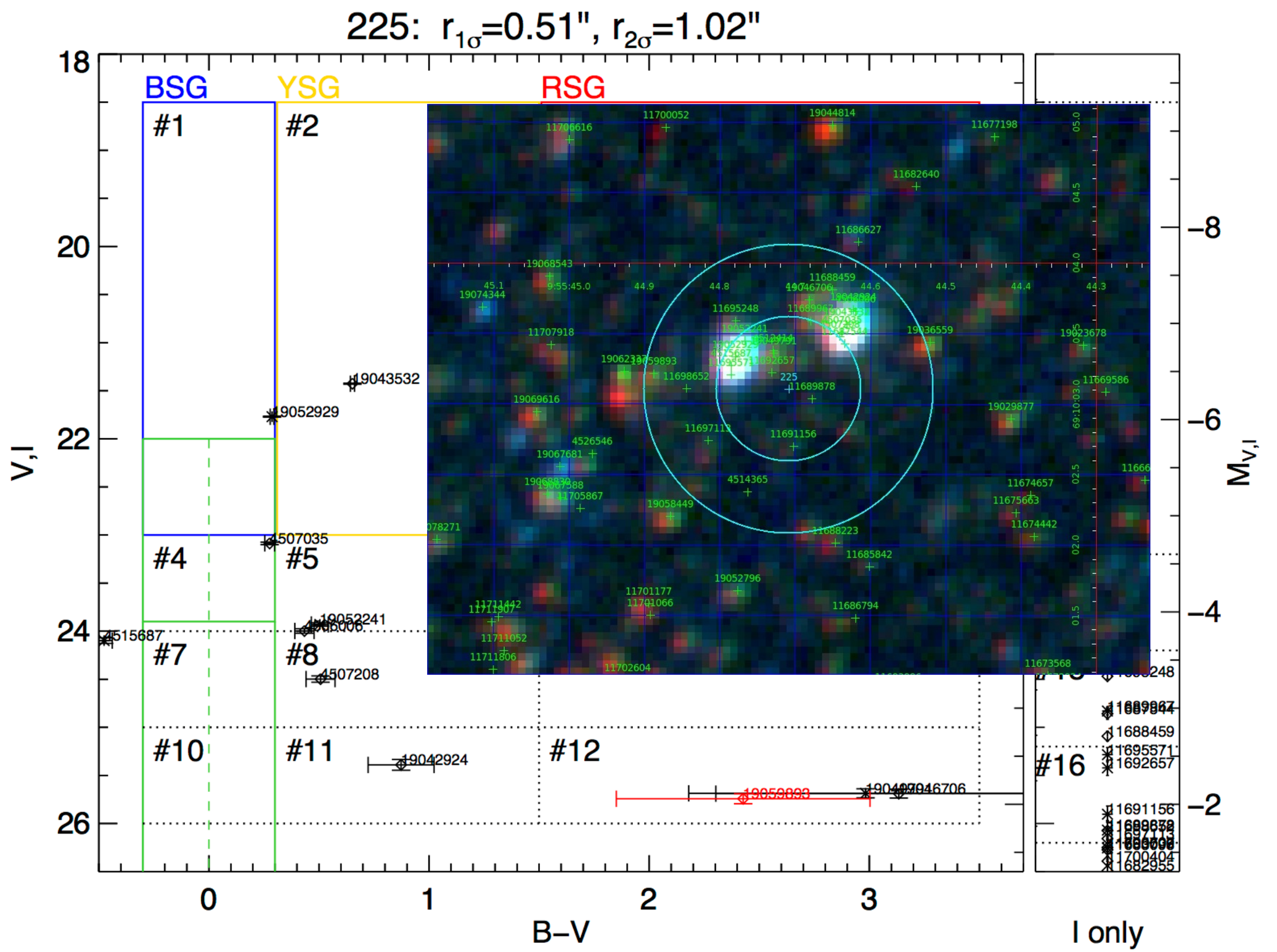
Source Classification in M81

Yellow Supergiant



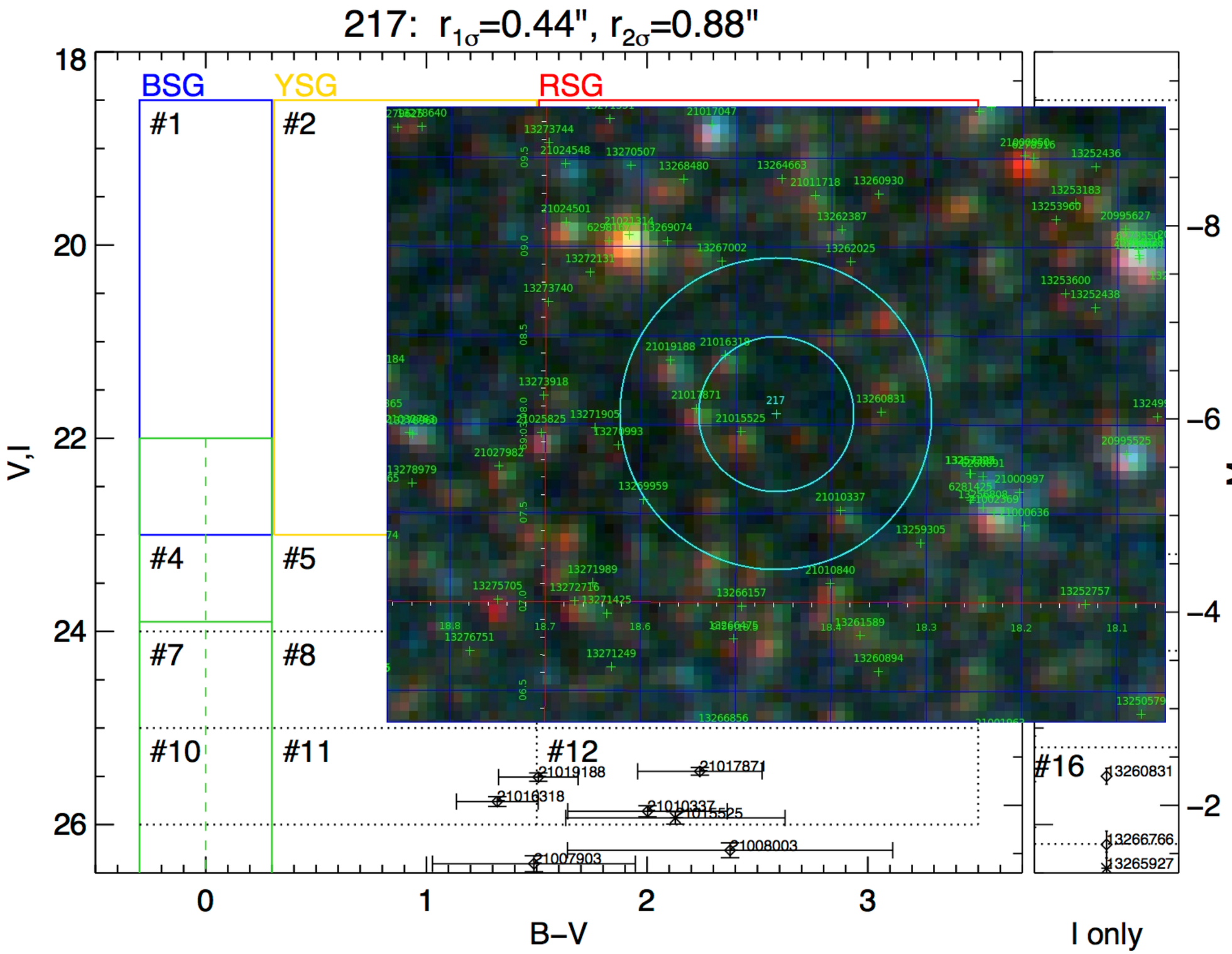
Source Classification in M81

Unknown HMXB



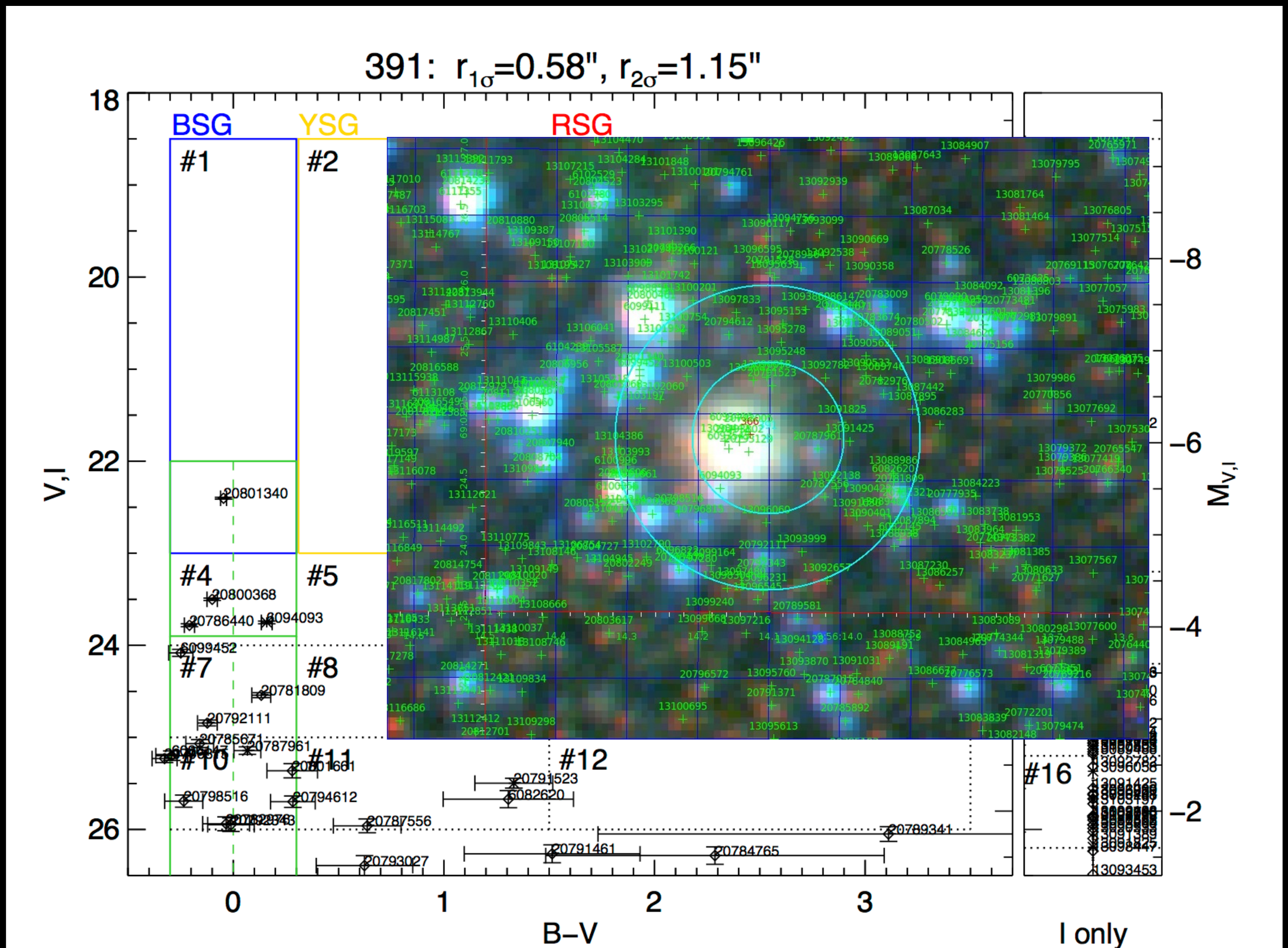
Source Classification in M81

Unknown LMXB

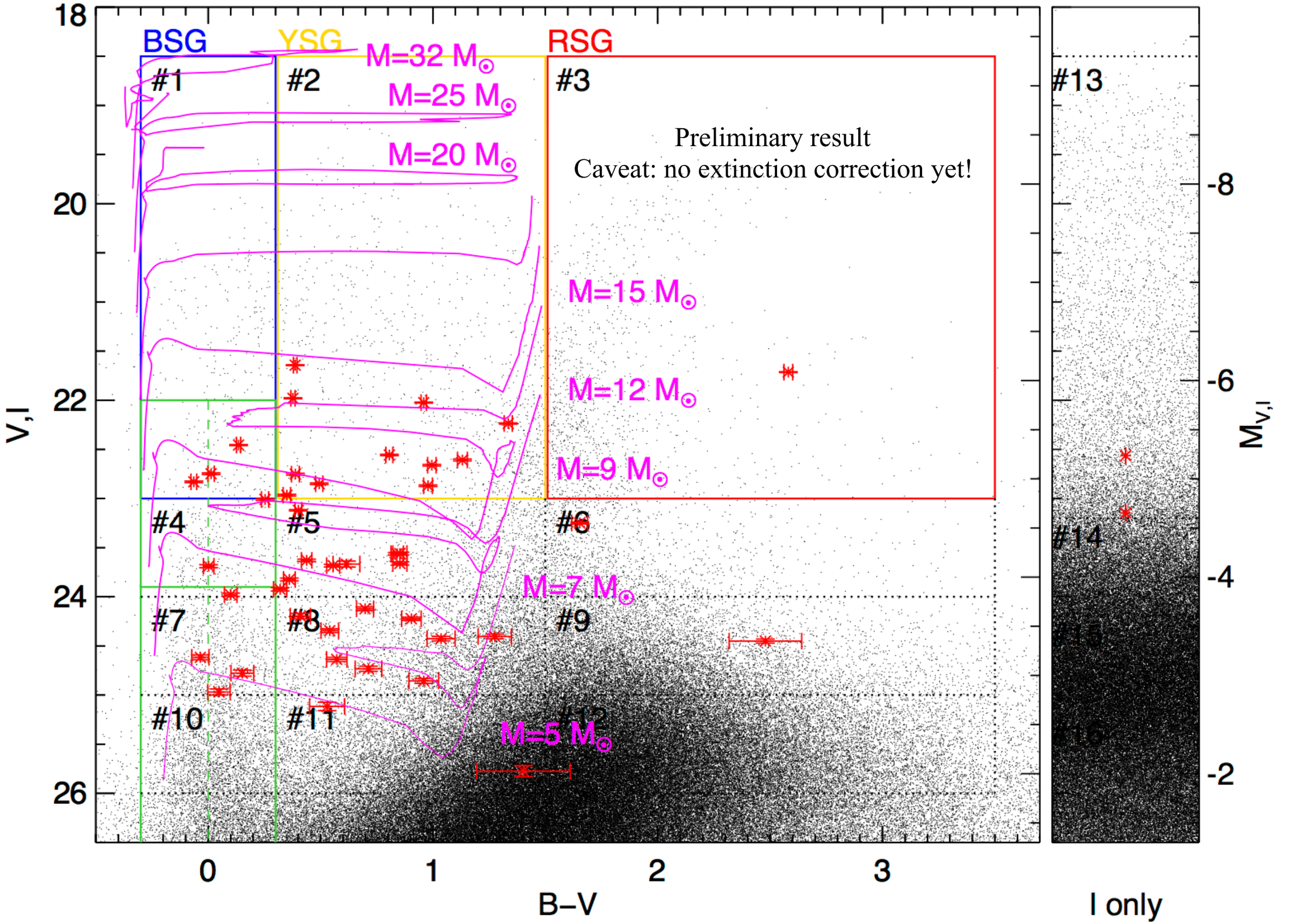


Source Classification in M81

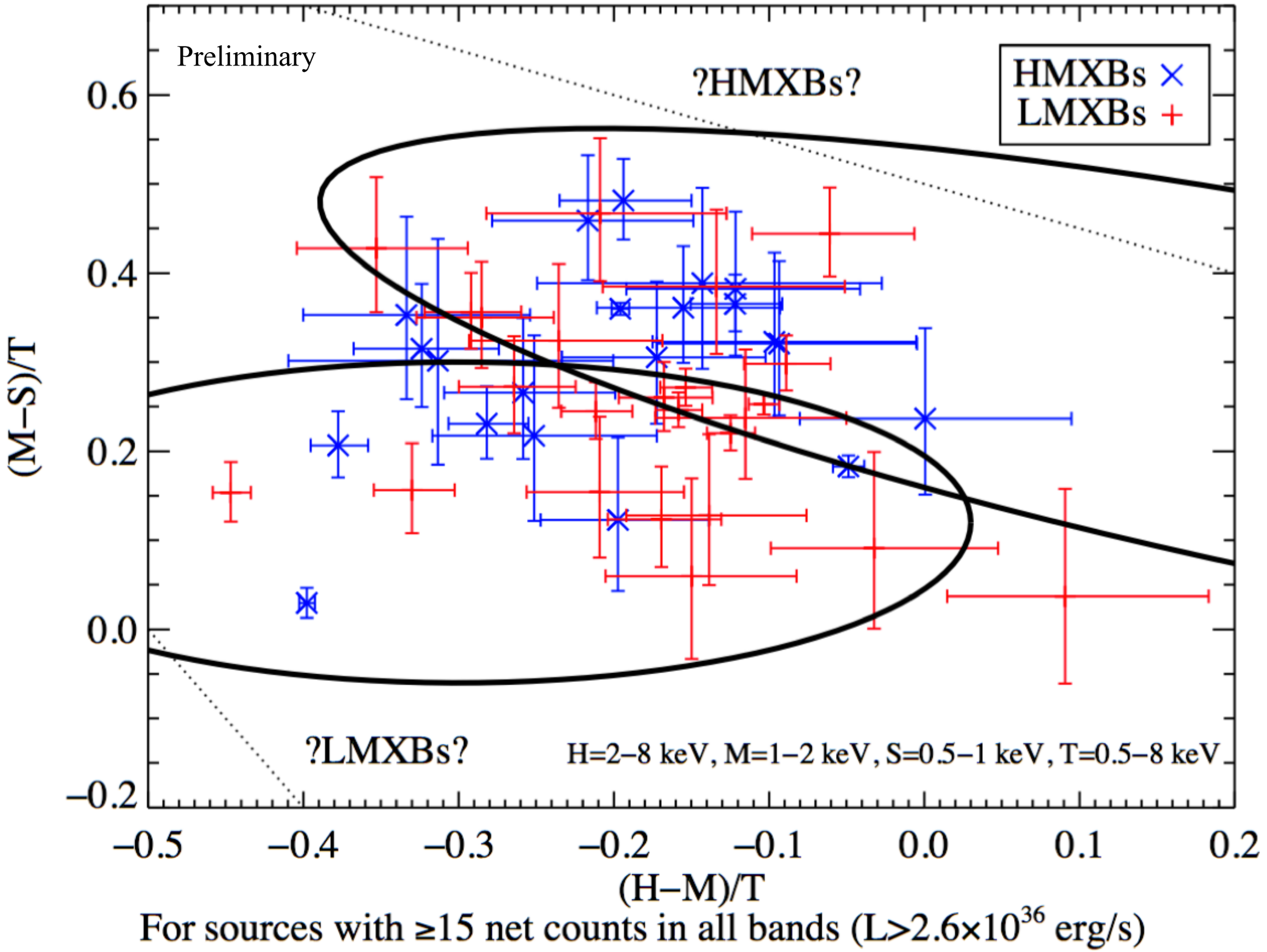
Indeterminate



CMD of All Uniquely Classified Sources

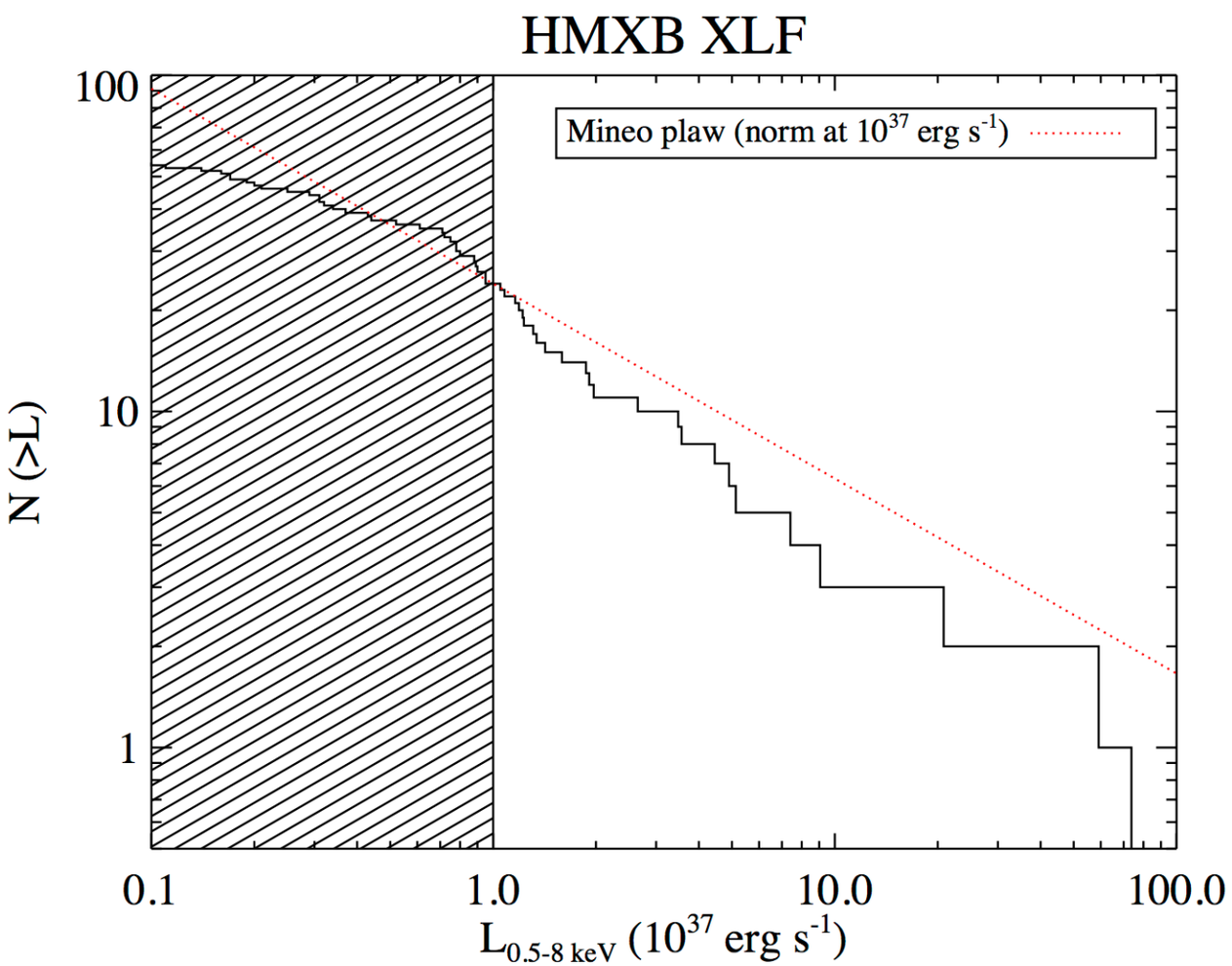


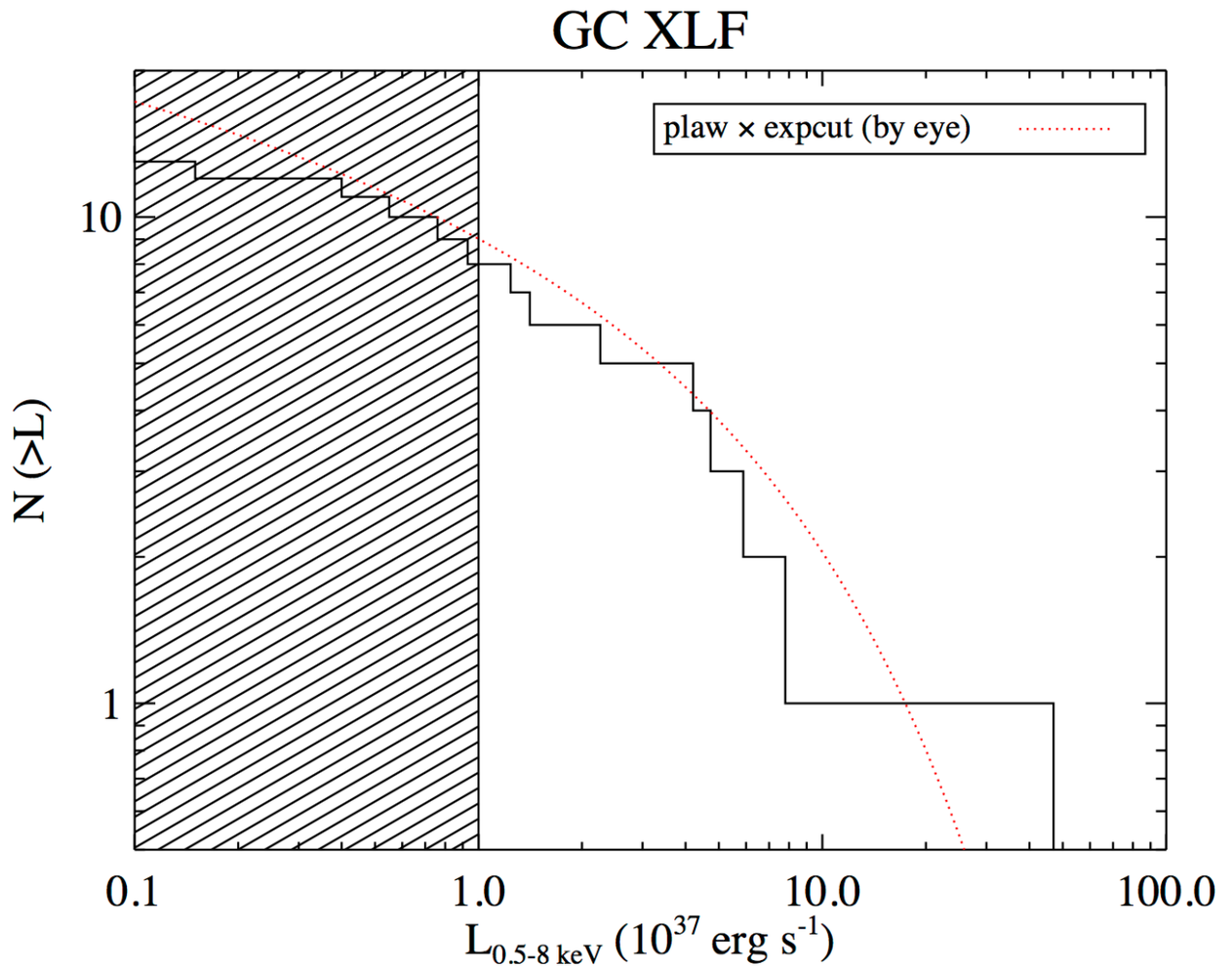
Prestwich et al. 2003 Diagnostics



For sources with ≥15 net counts in all bands ($L>2.6\times10^{36}$ erg/s)

Preliminary Luminosity Functions

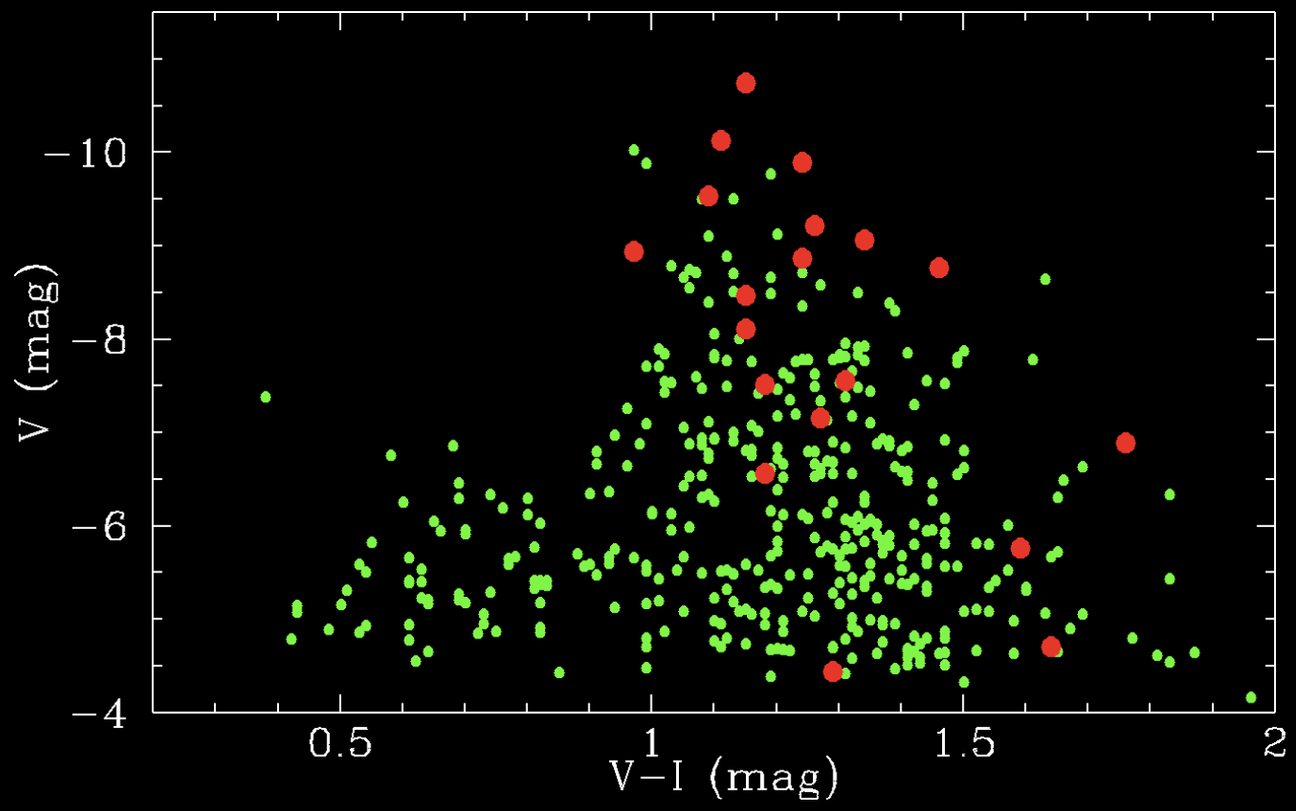


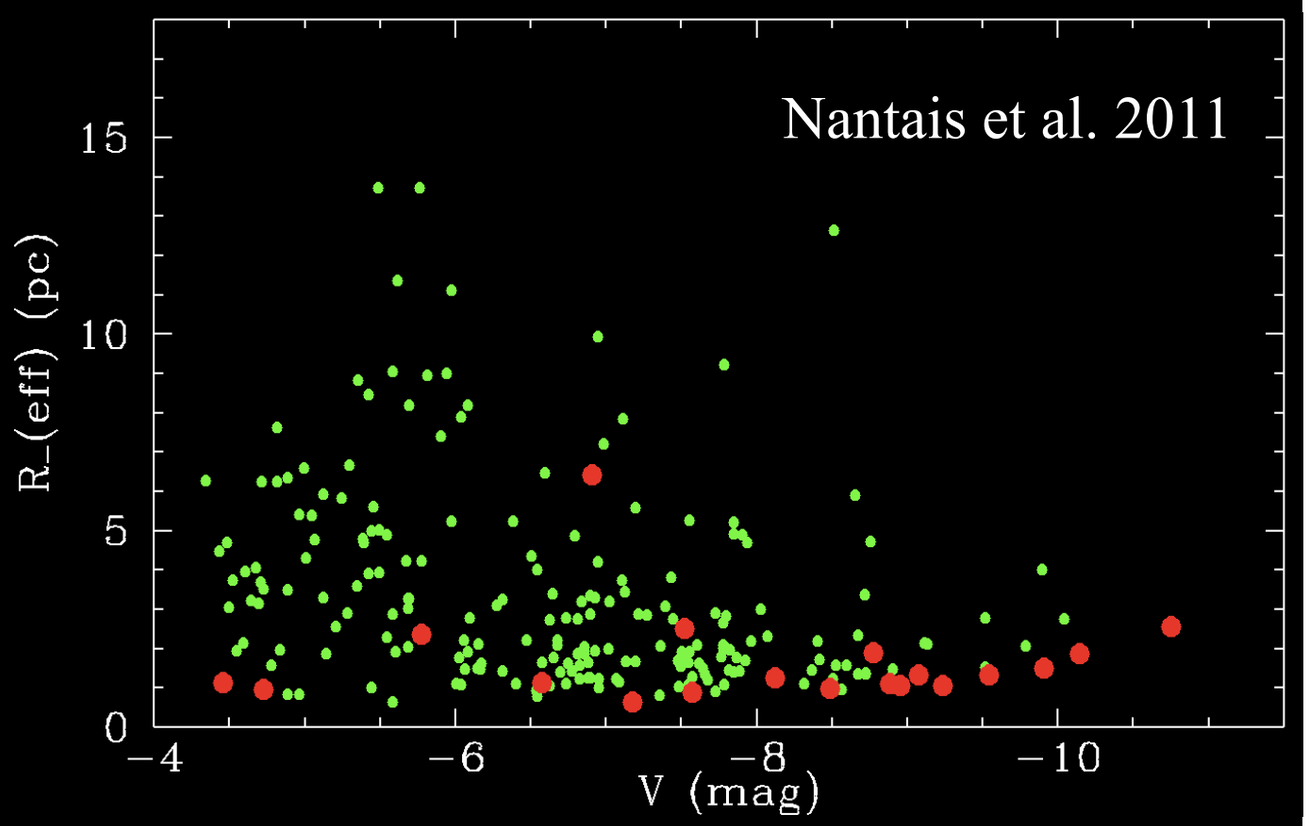


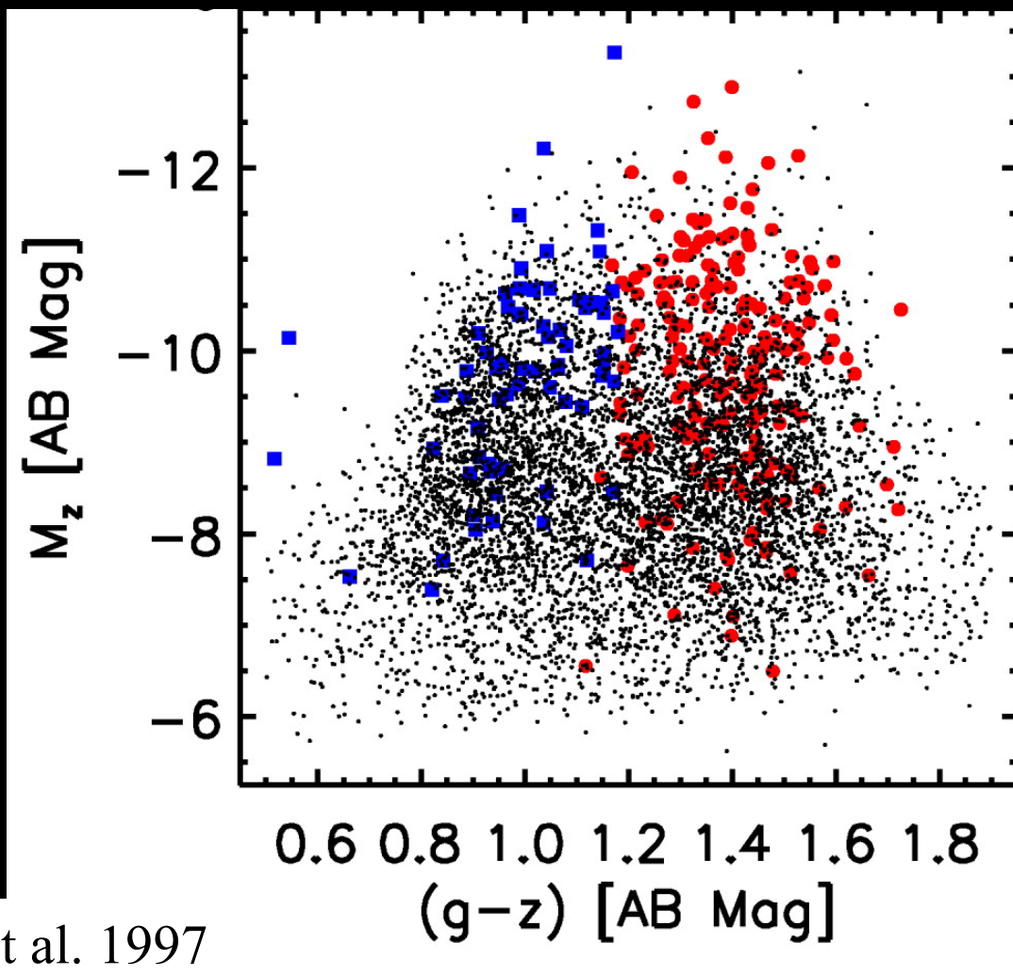
Not corrected for incompleteness or fit yet!

- Contamination
  - Bulge with HMXBs: <~10%
  - Fraction of HMXBs in the disk: ~1/3–1/2 of the sources!

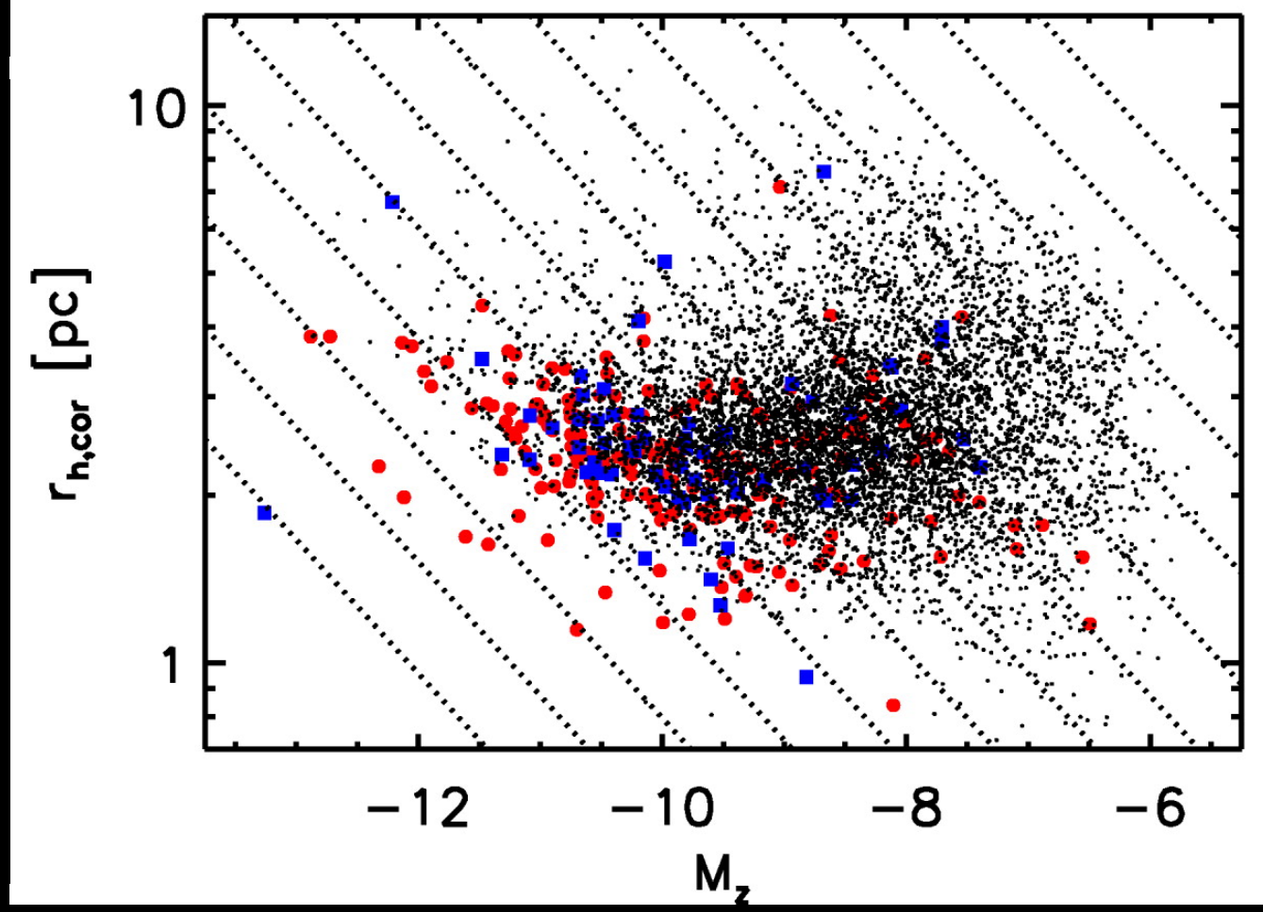
Globular Cluster LMXBs







Sivakoff et al. 1997



Summary

- We classify individual X-ray sources
- X-ray colors should not be used to differentiate the nature of the companion
- A “pure” HMXB XLF may be steeper?
- Globular cluster LMXBs associated with redder, more massive, and denser clusters
- Explore other interesting source types: Be XRBs…