The Stellar Halo of M31

Chemical Abundance Patterns and Coadded Spectra

Raja Guhathakurta

(on behalf of the SPLASH collaboration)

University of California Observatories /
University of California Santa Cruz

Thu July 14, 2011

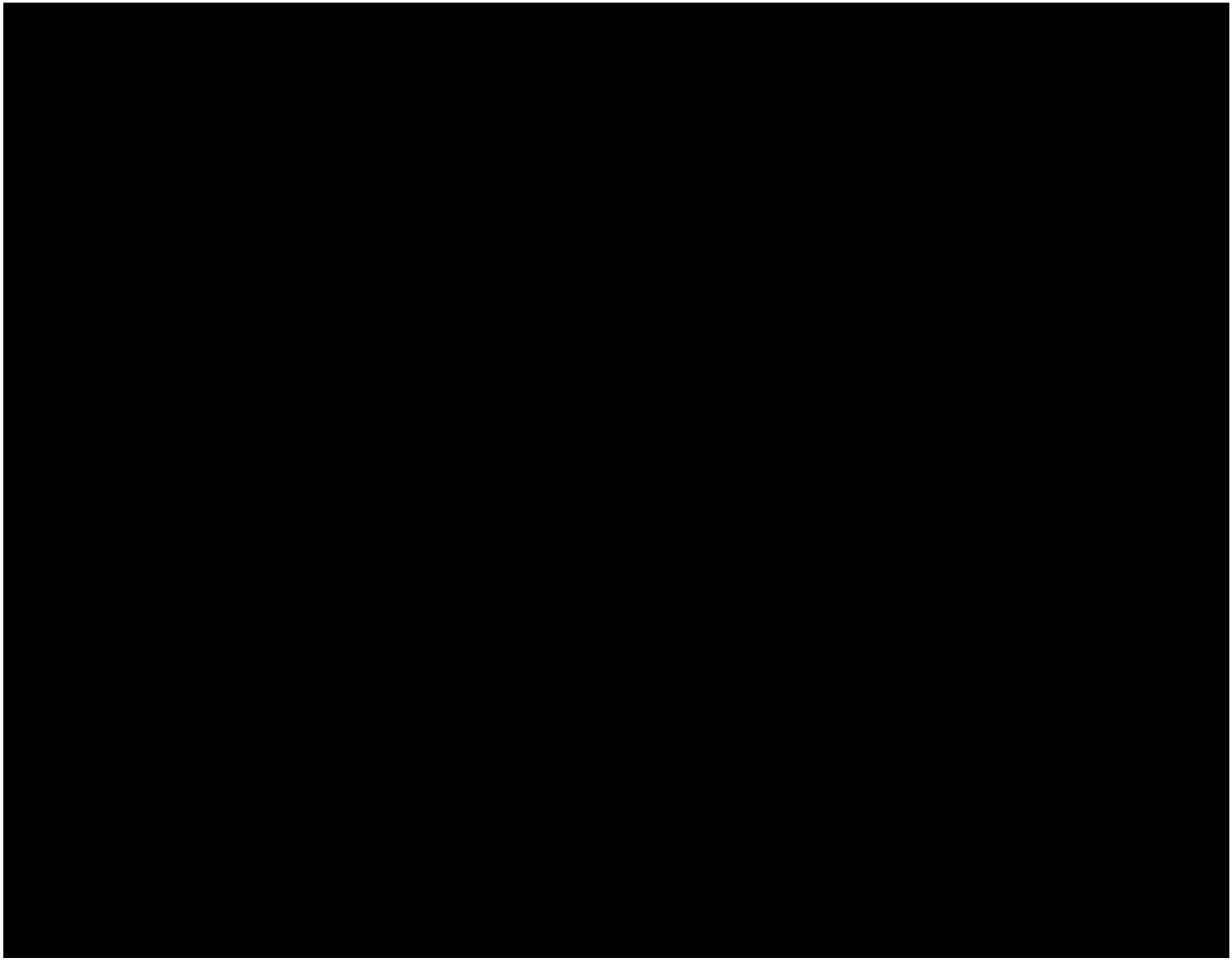
KraftFest, UCS

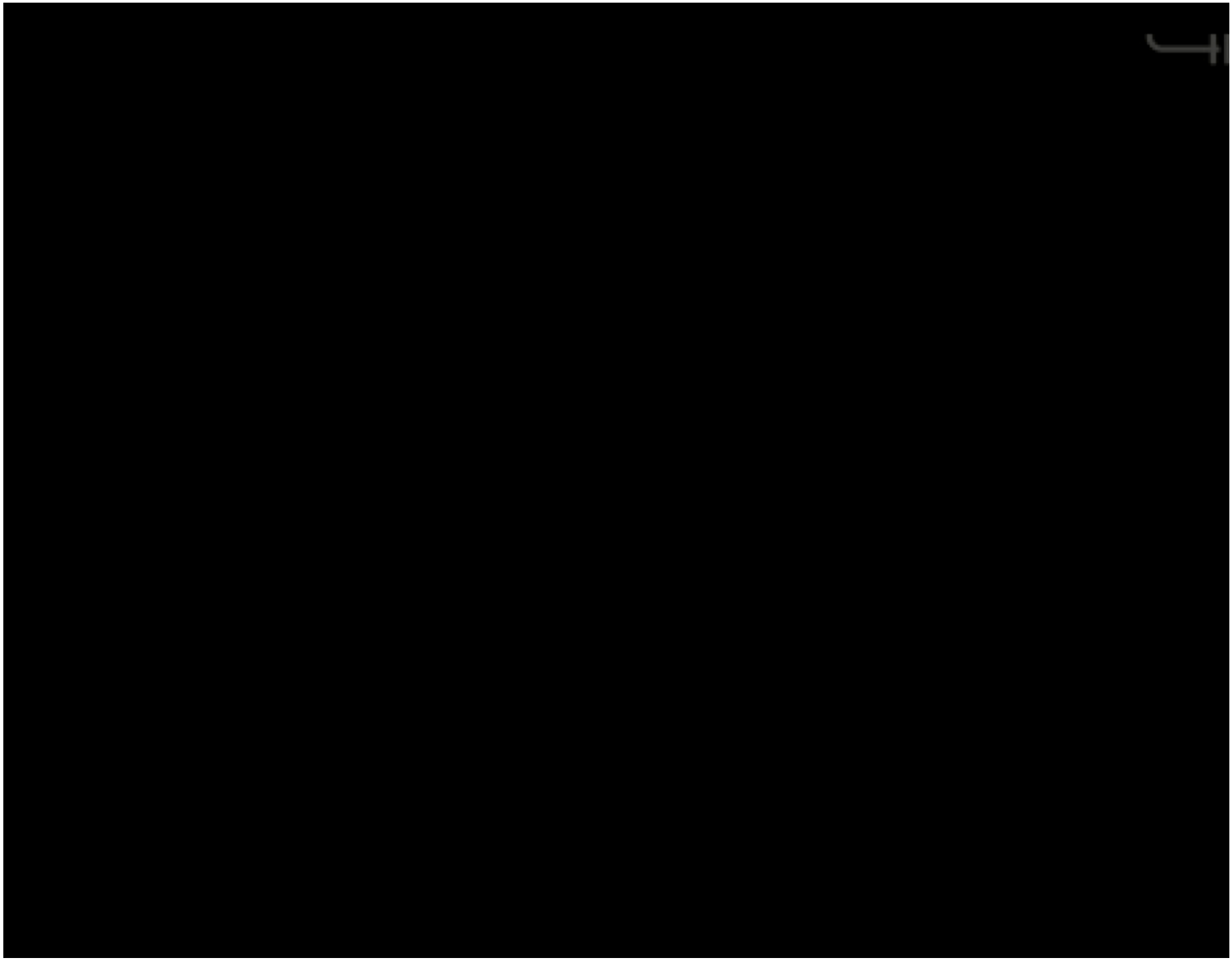
Outline

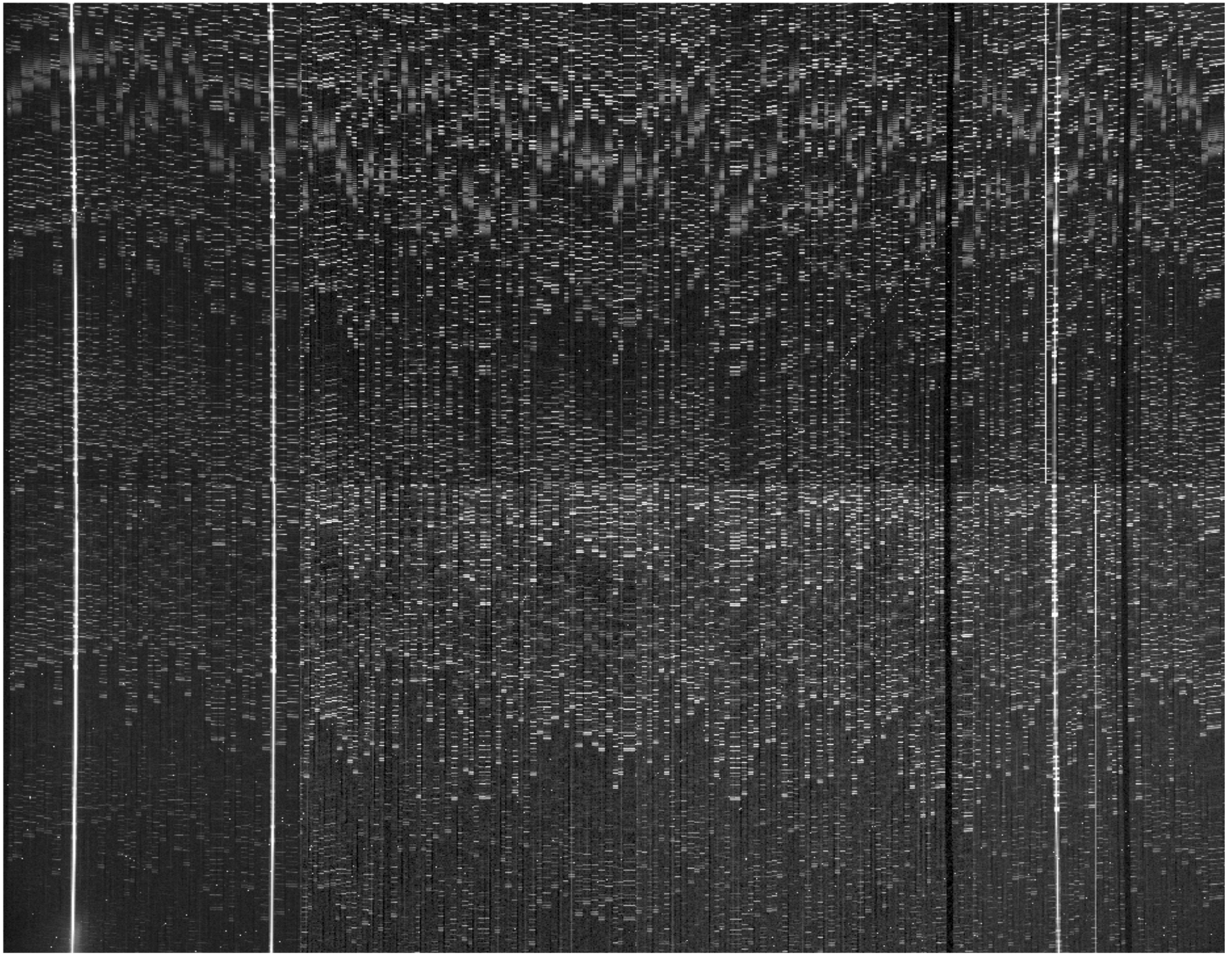
Andromeda:
A fossil record of hierarchical galaxy formation

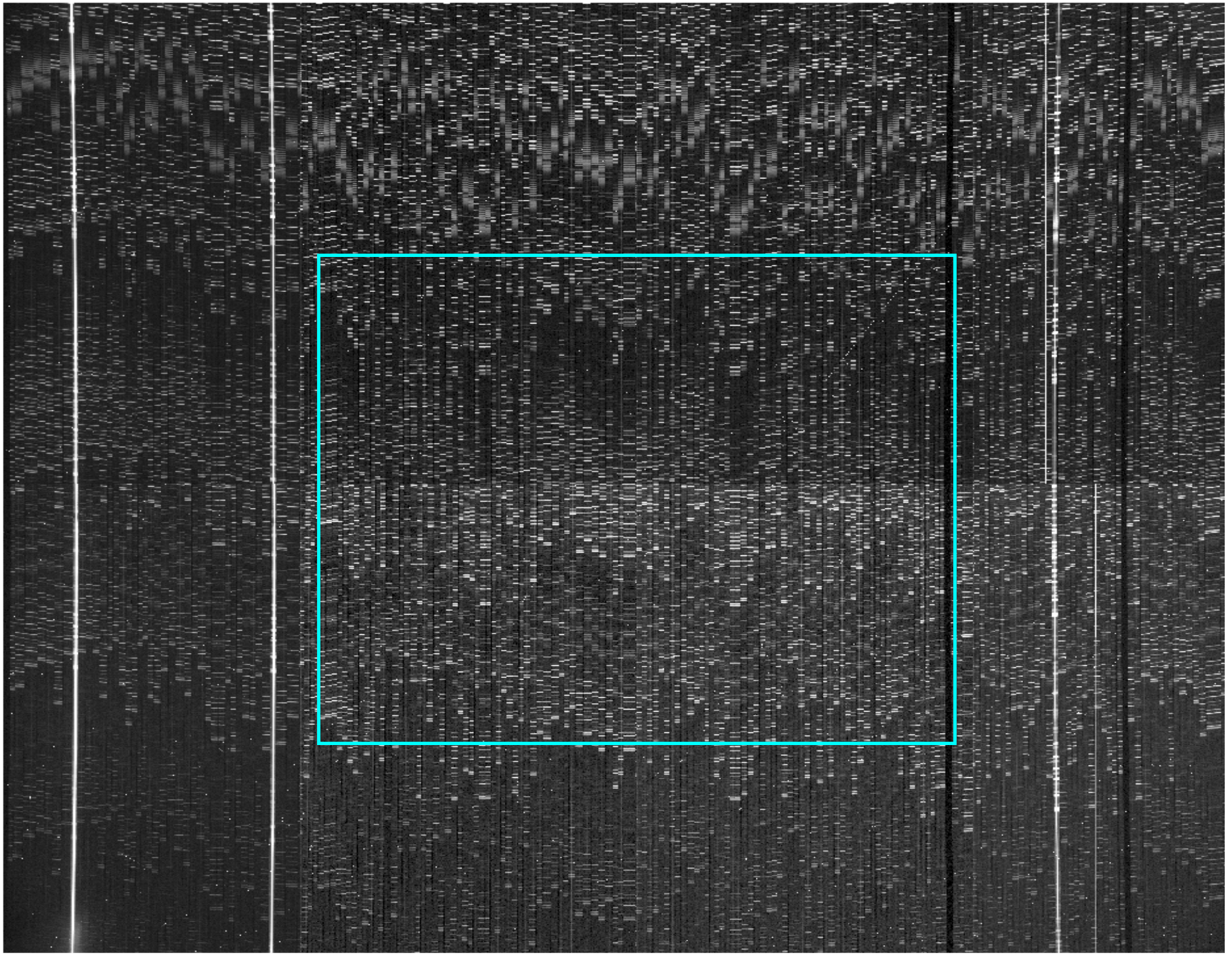
- M31's stellar halo
  Tangential motion of M31 system
- Inner spheroid, disk, central bulge
- Tidal streams
- Dwarf satellite galaxies

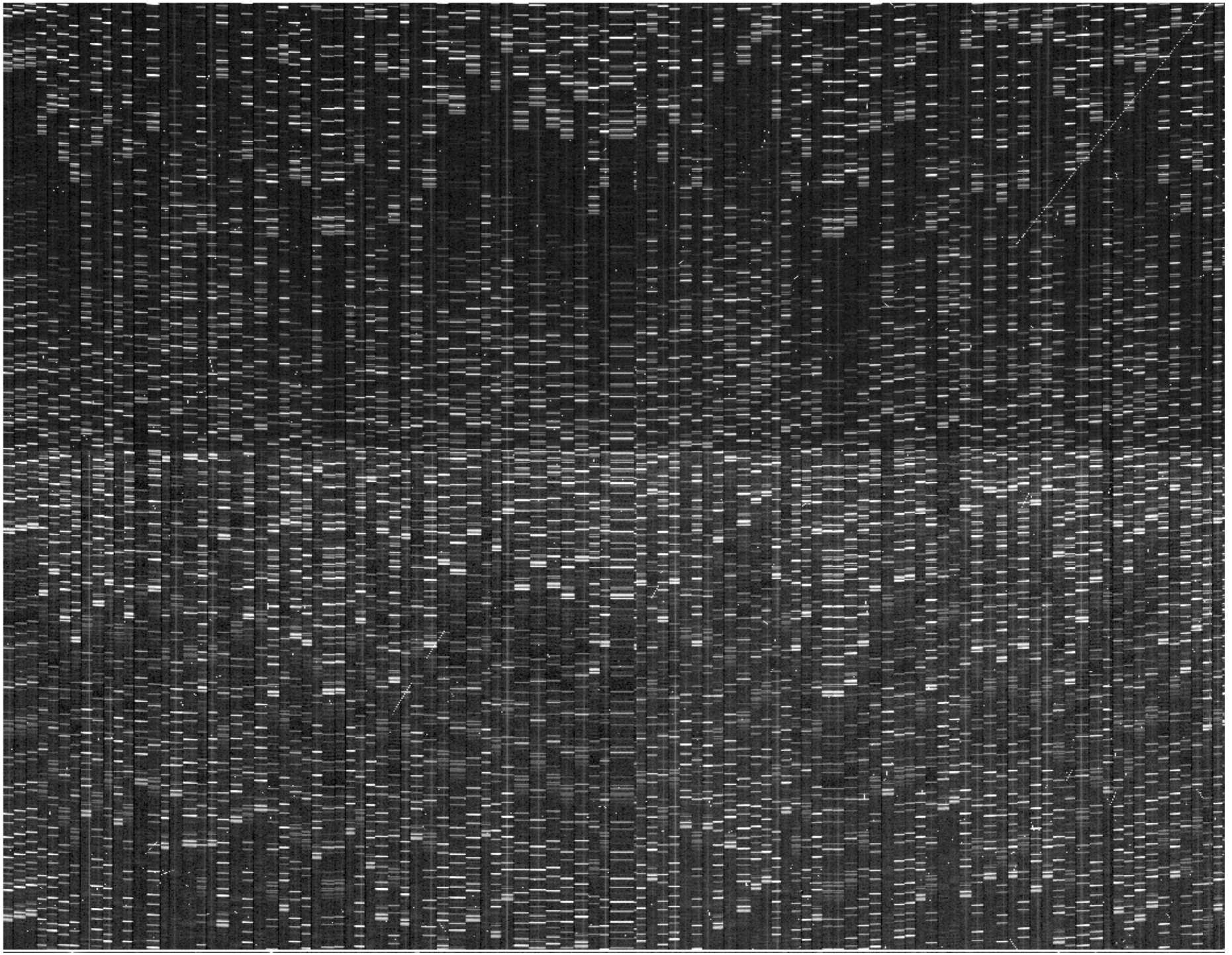
Summary
(and a fond rememberance)

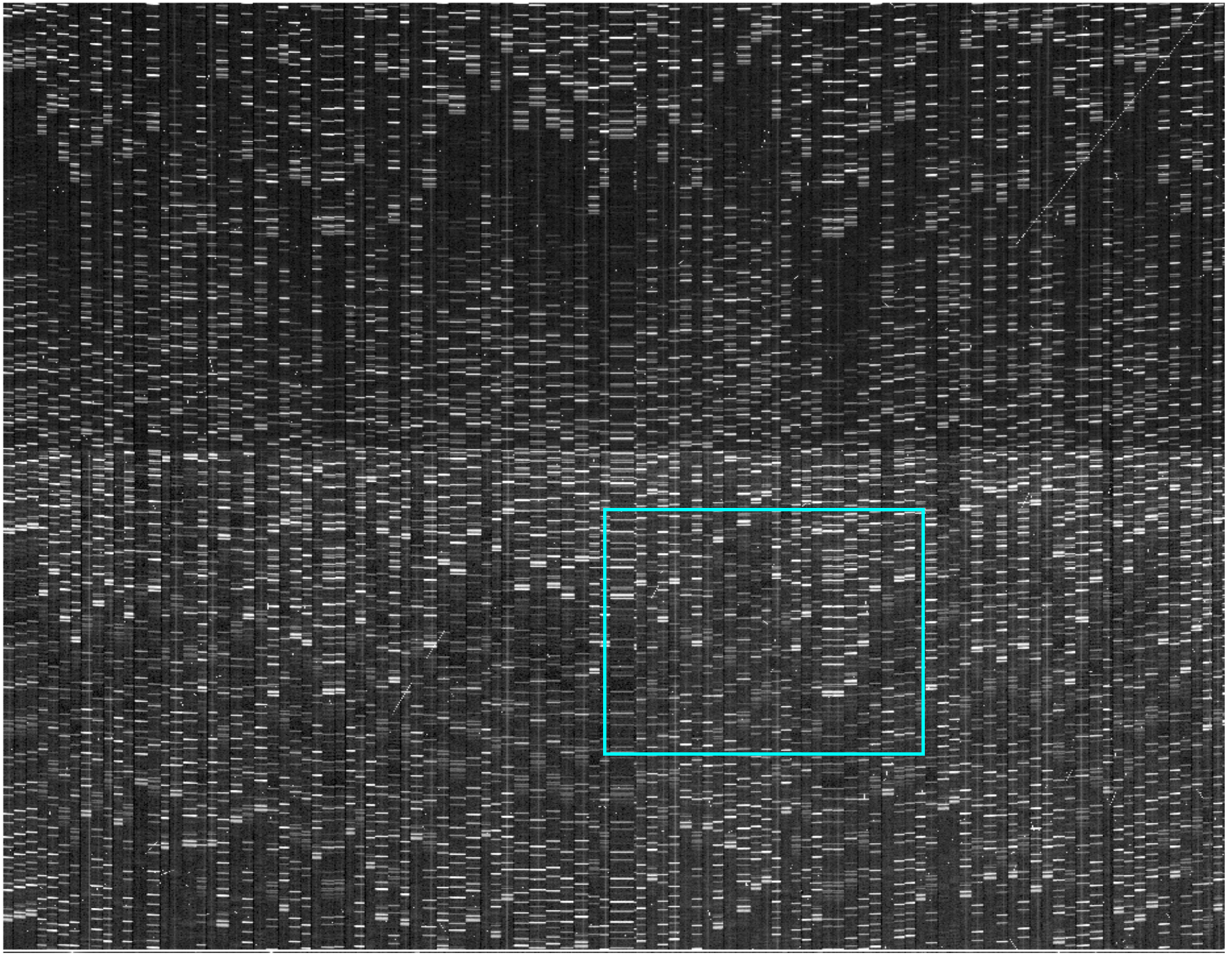


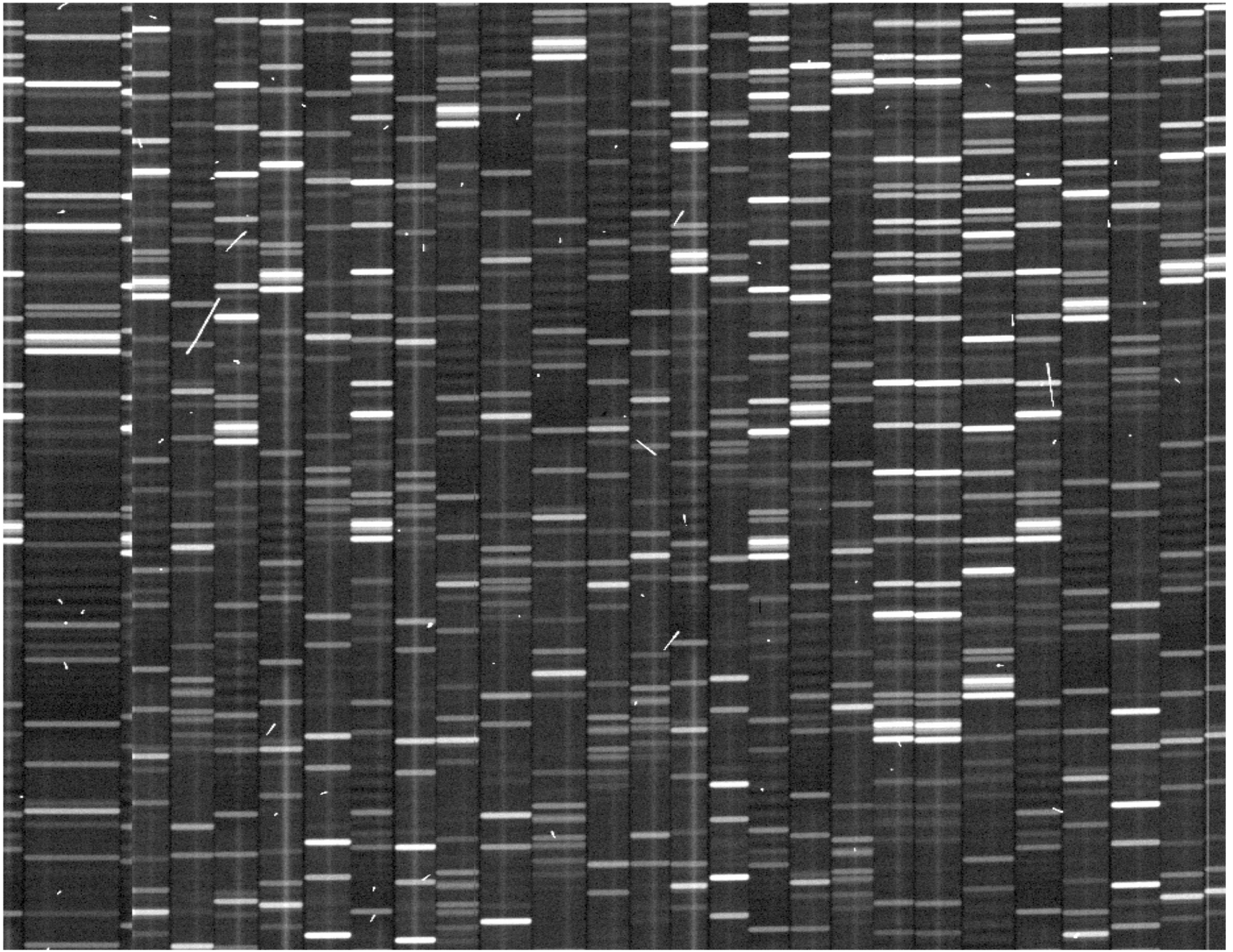








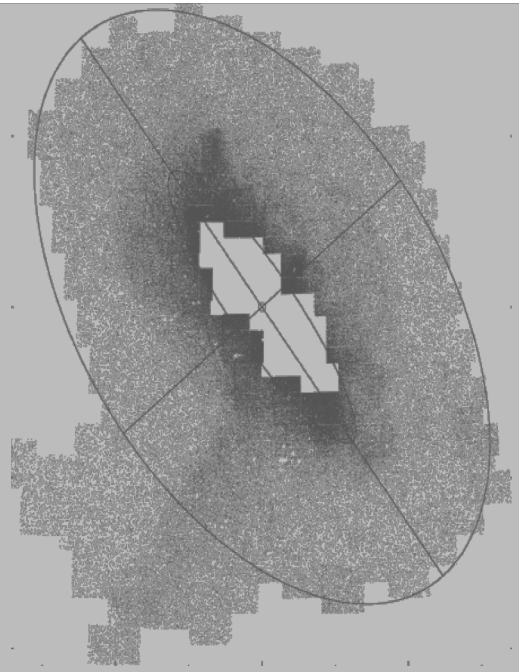




Andromeda offers an ideal laboratory

- The other giant galaxy in the Local Group of galaxies
- Distant enough that we have a global external view: all stars appear to be at approximately the same distance and reddening
- Near enough to resolve individual stars: bright red giants (spectroscopy), horizontal branch stars (deep wide-field ground-based imaging), and main-sequence stars (ultra-deep HST imaging)
- Disk is inclined nearly edge-on; this should help disk / spheroid separation

Spectroscopy of the Remote Outer Halo of M31



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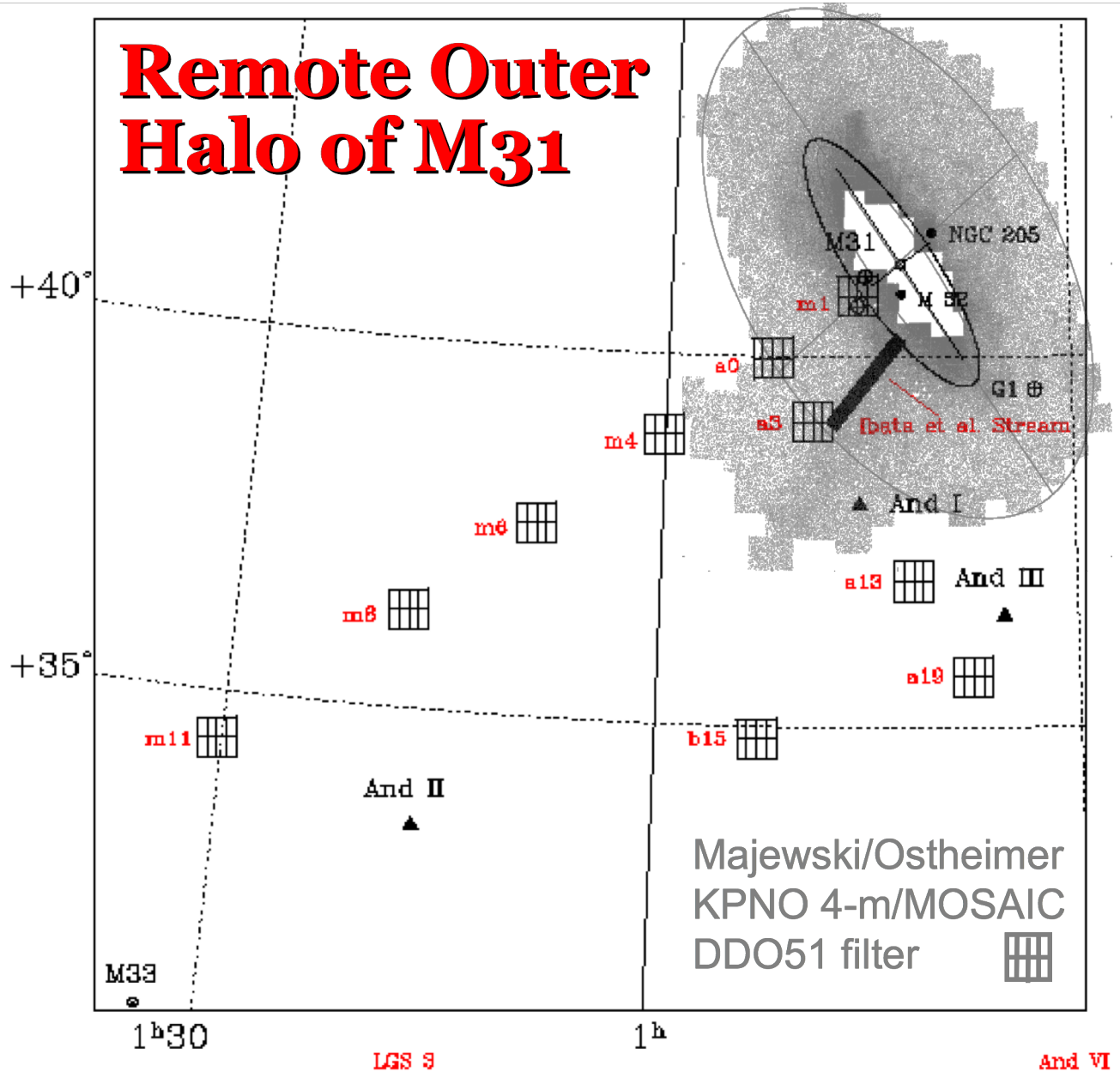

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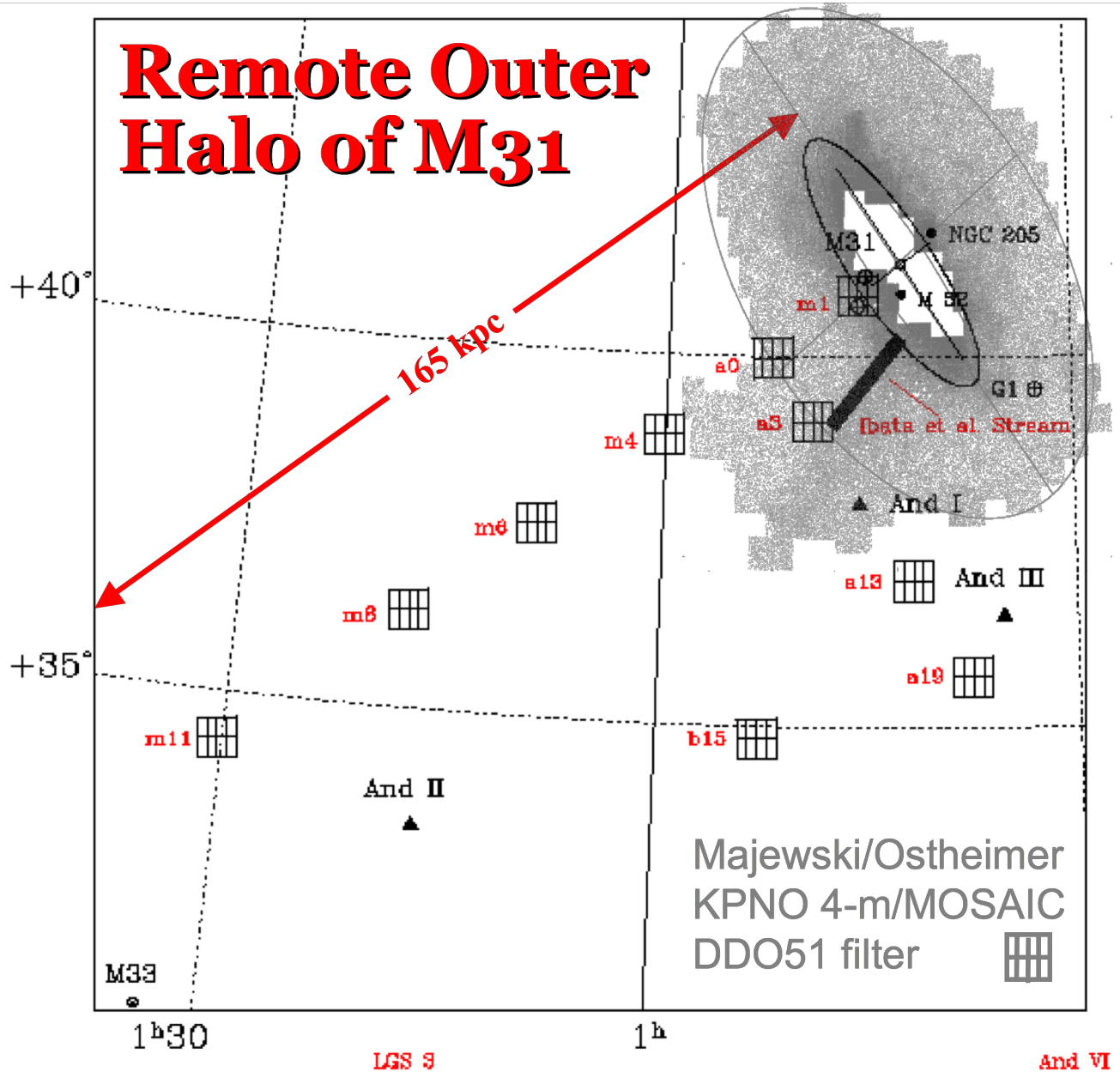

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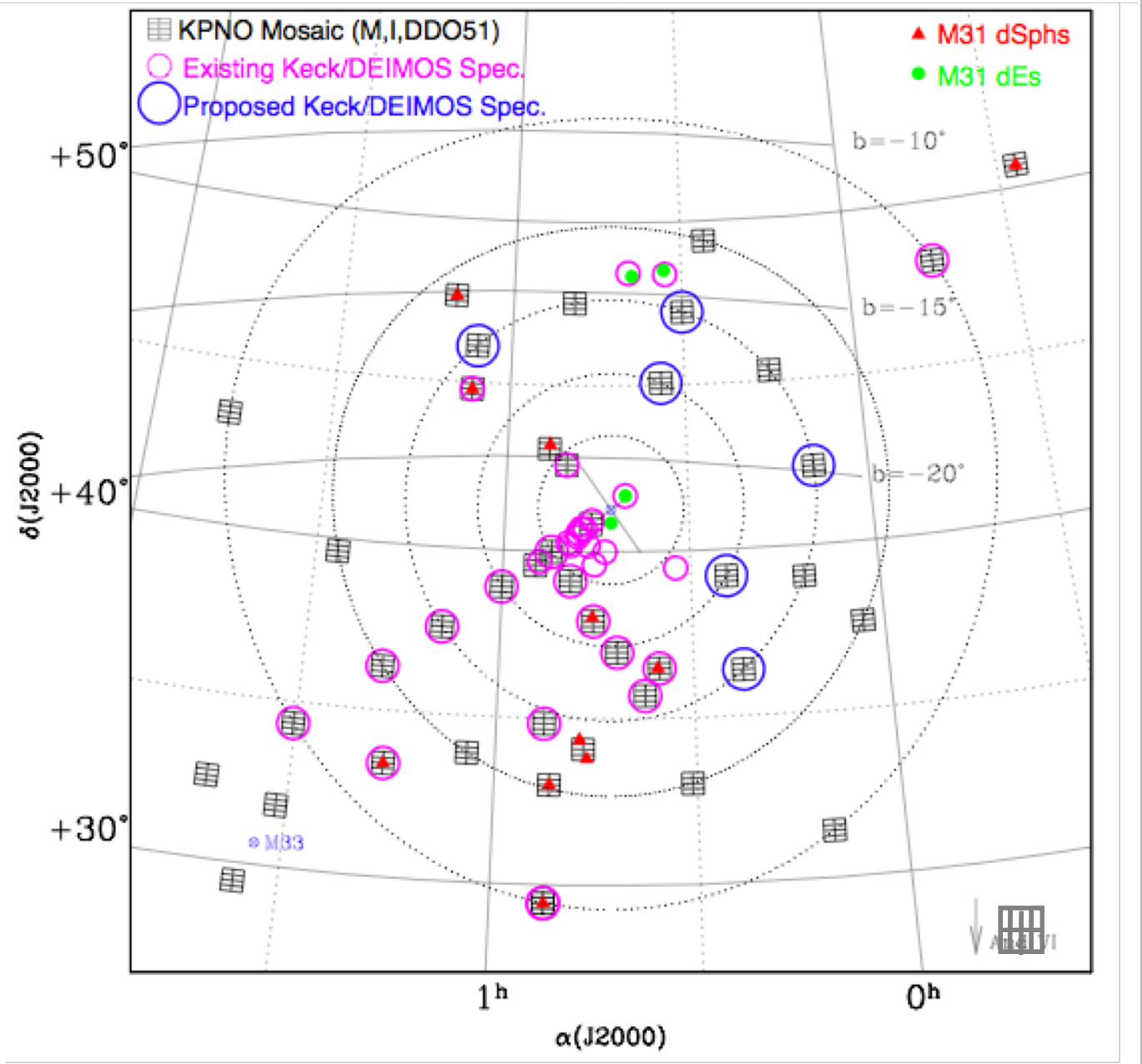

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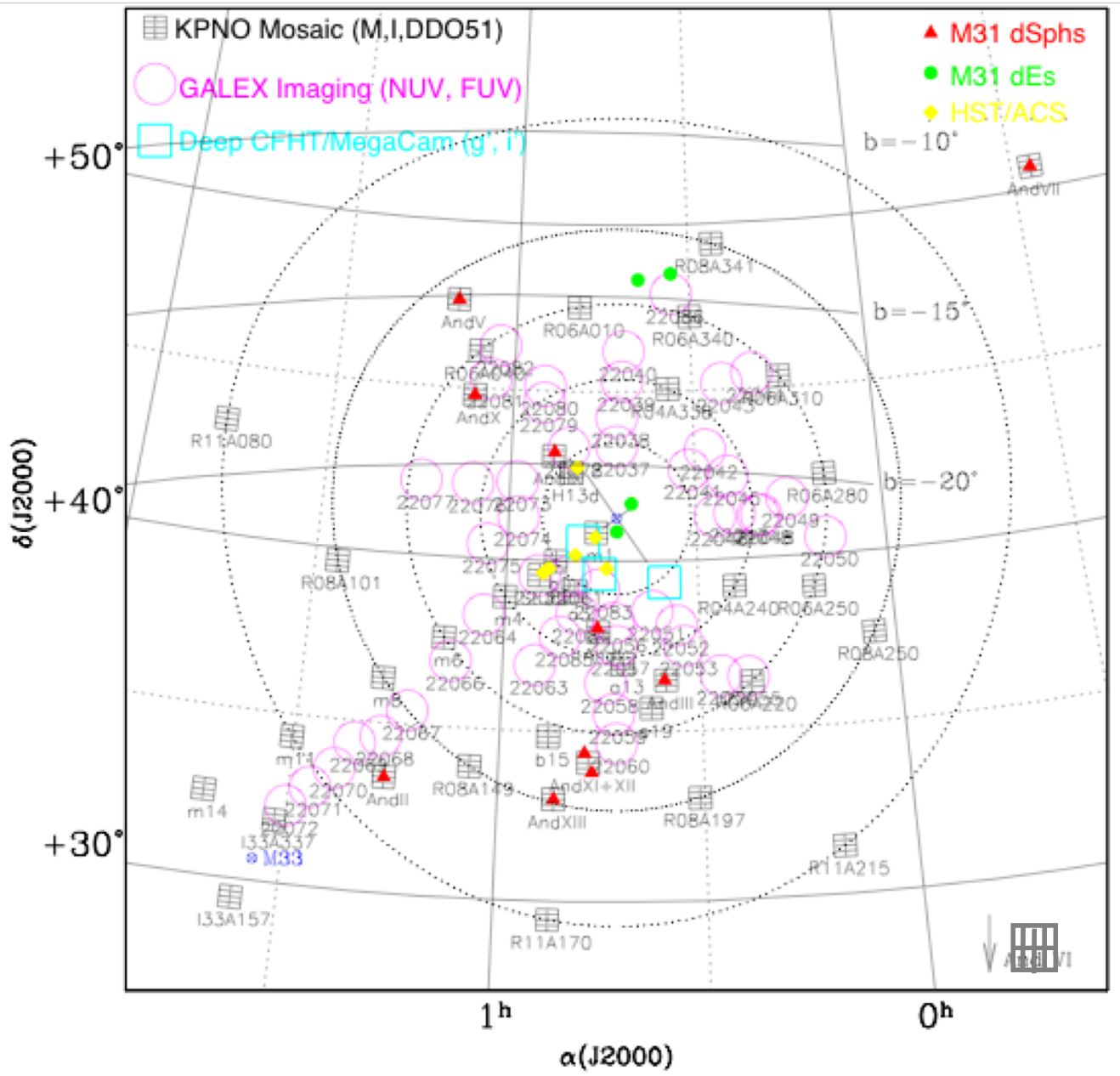

Ostheimer (2002, PhD thesis)
Beaton et al. (in prep)
Kalirai et al. (2006a)

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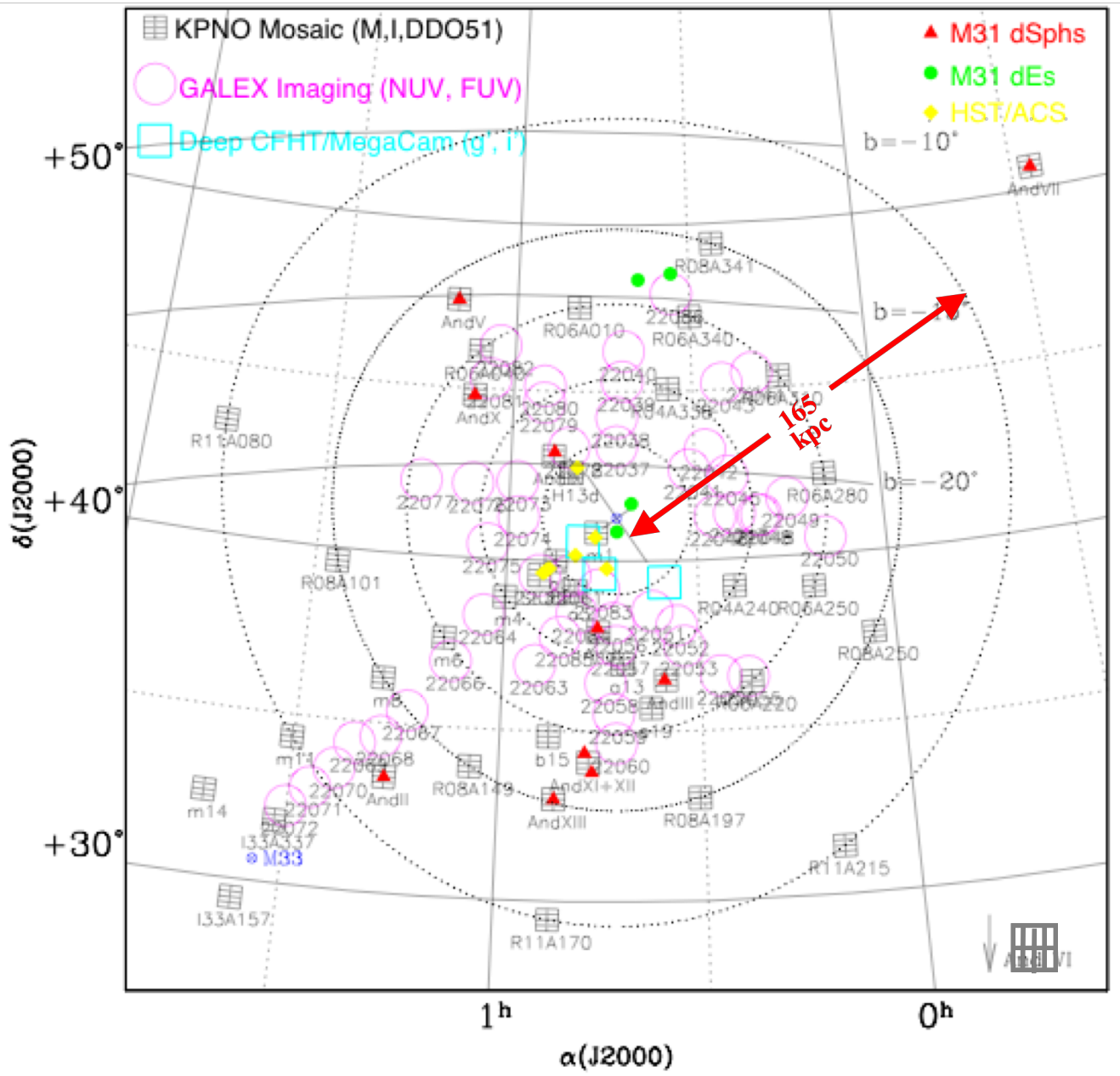

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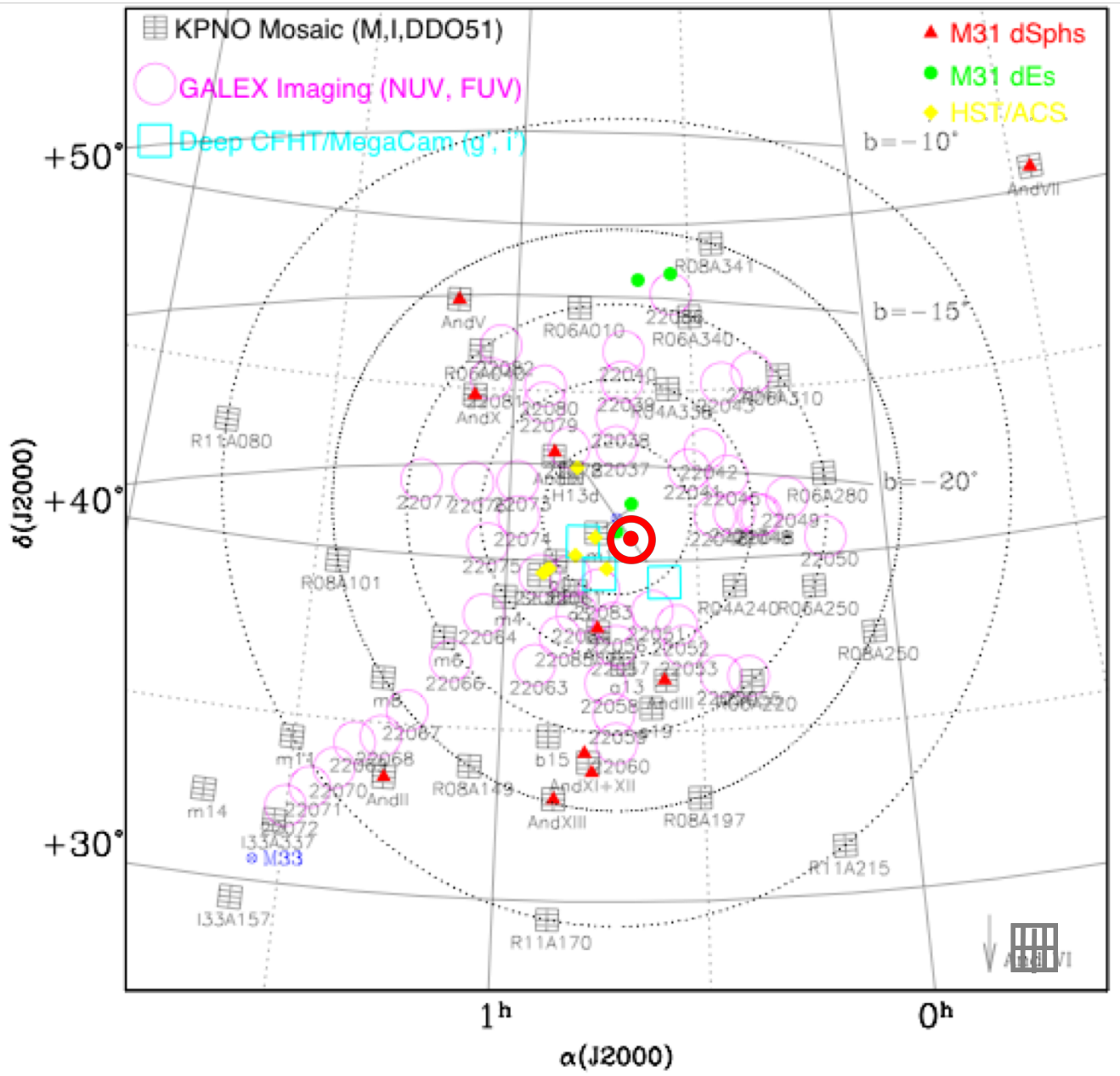

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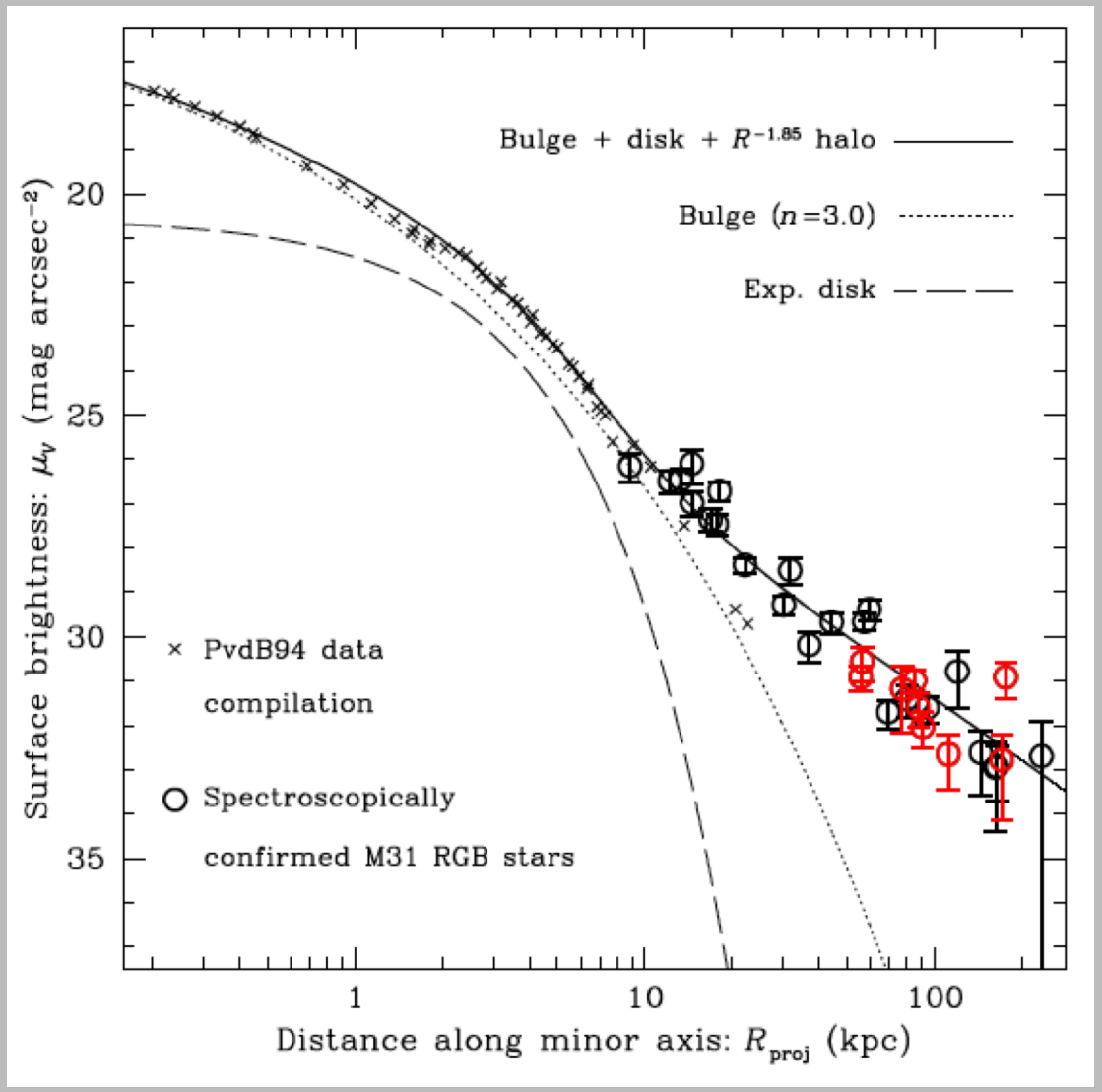
Tidal Streams and M31's Surface Brightness Profile



Gilbert, PG, et al. (2011, in pre

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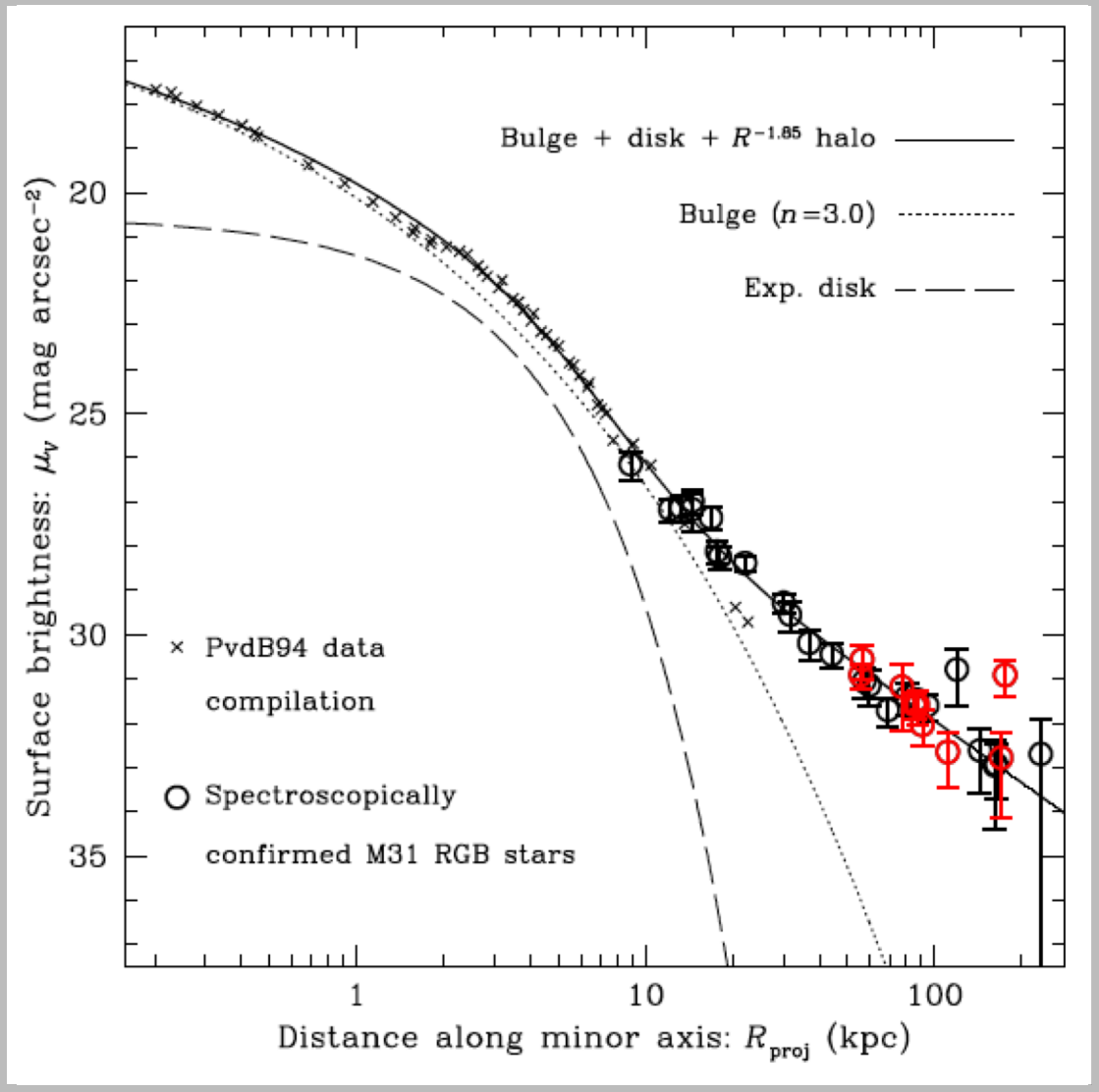

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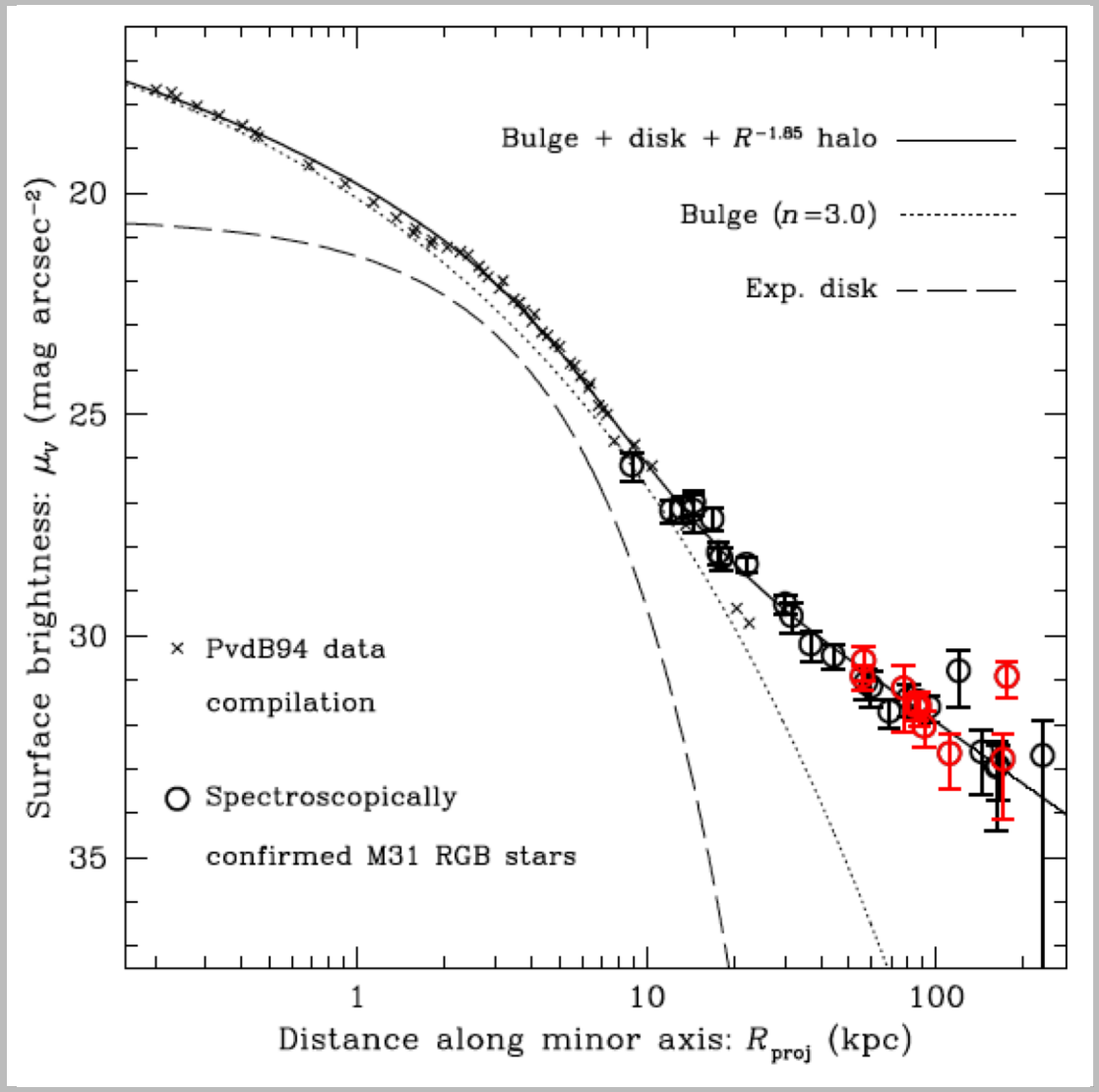
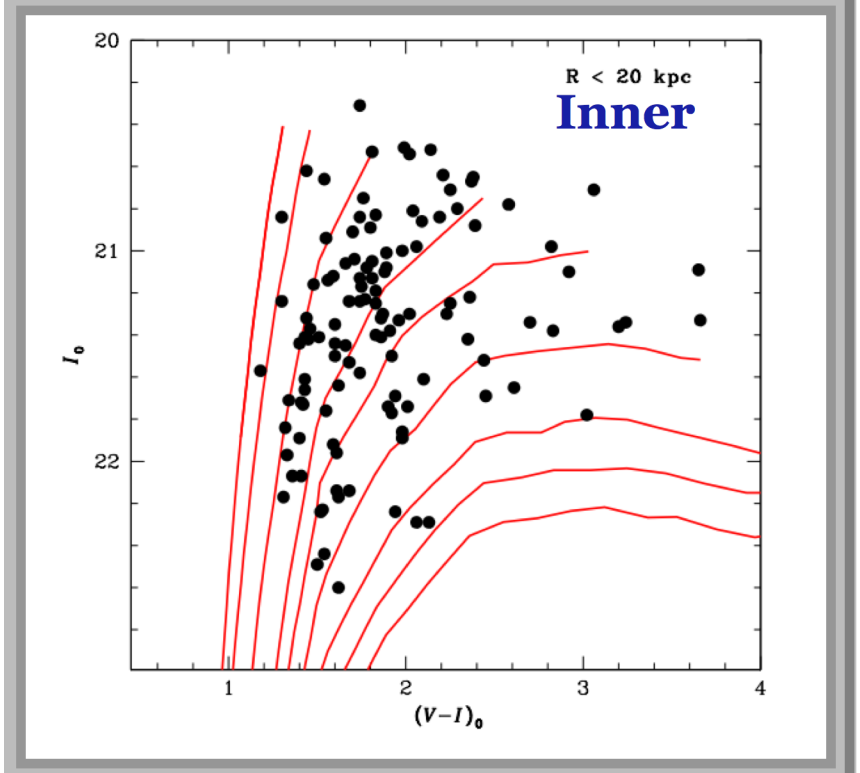
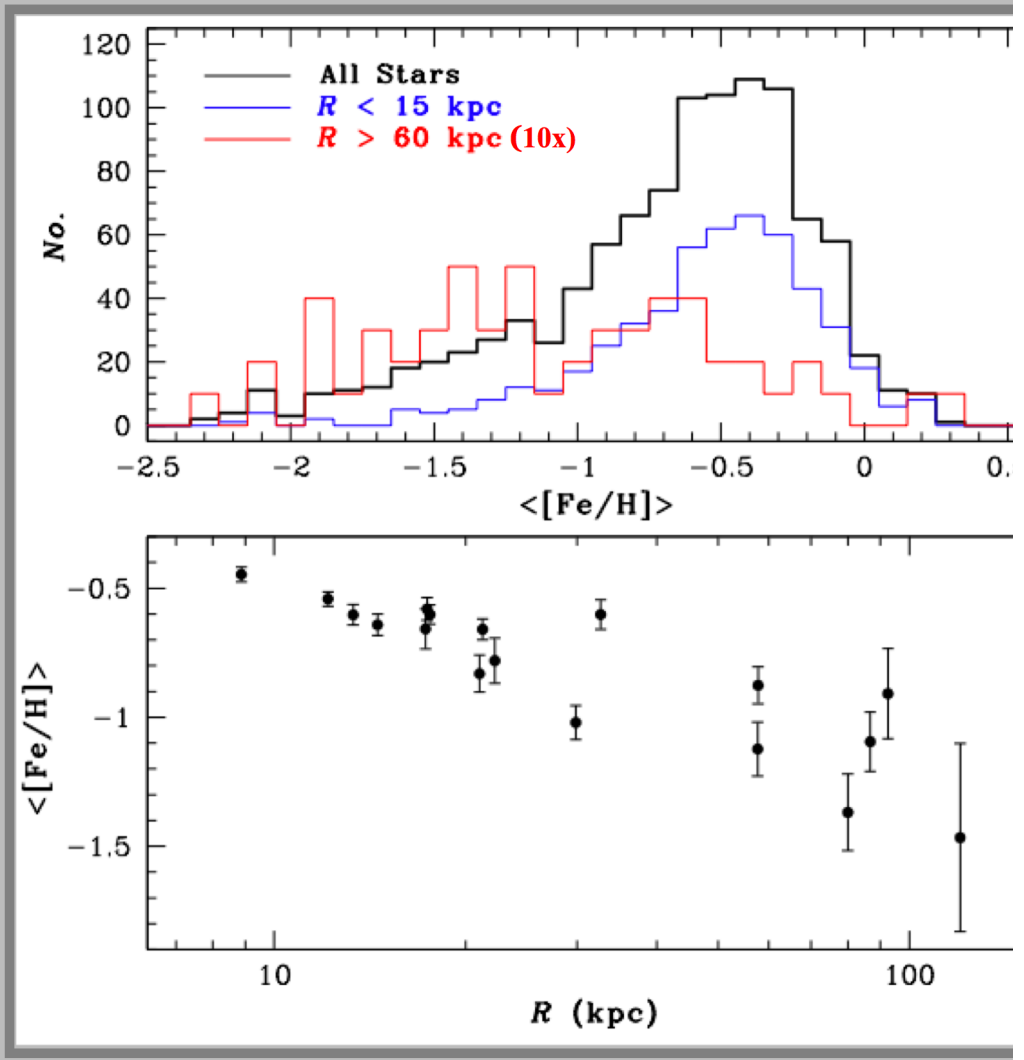


The removal of kinematically-cold components (tidal streams) leads to a smoother surface brightness profile

Gilbert, PG, et al. (2011, in pre

Radial Gradient in Metallicity





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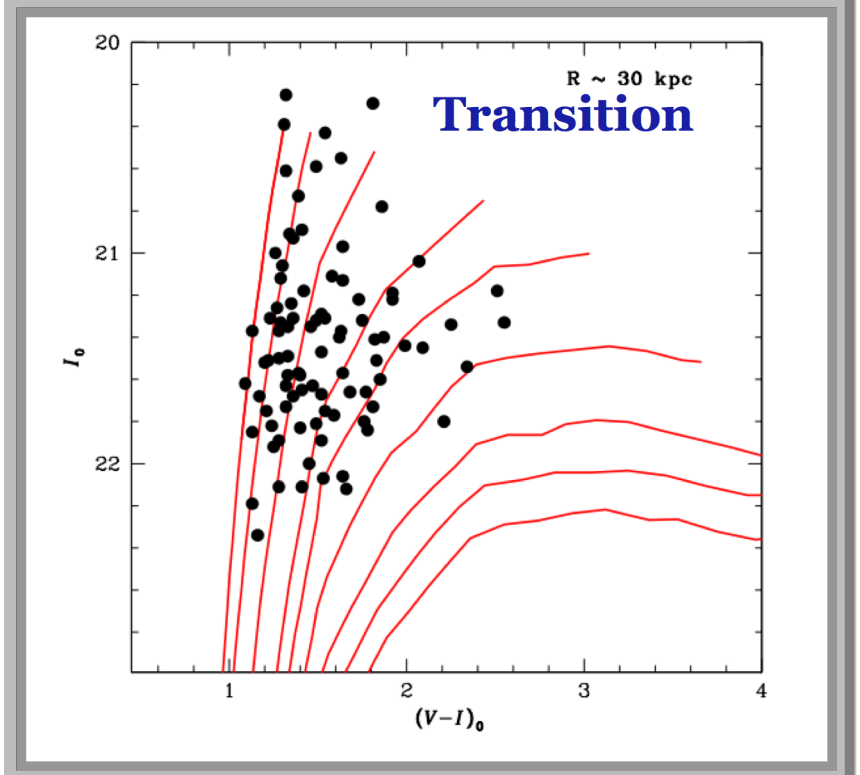

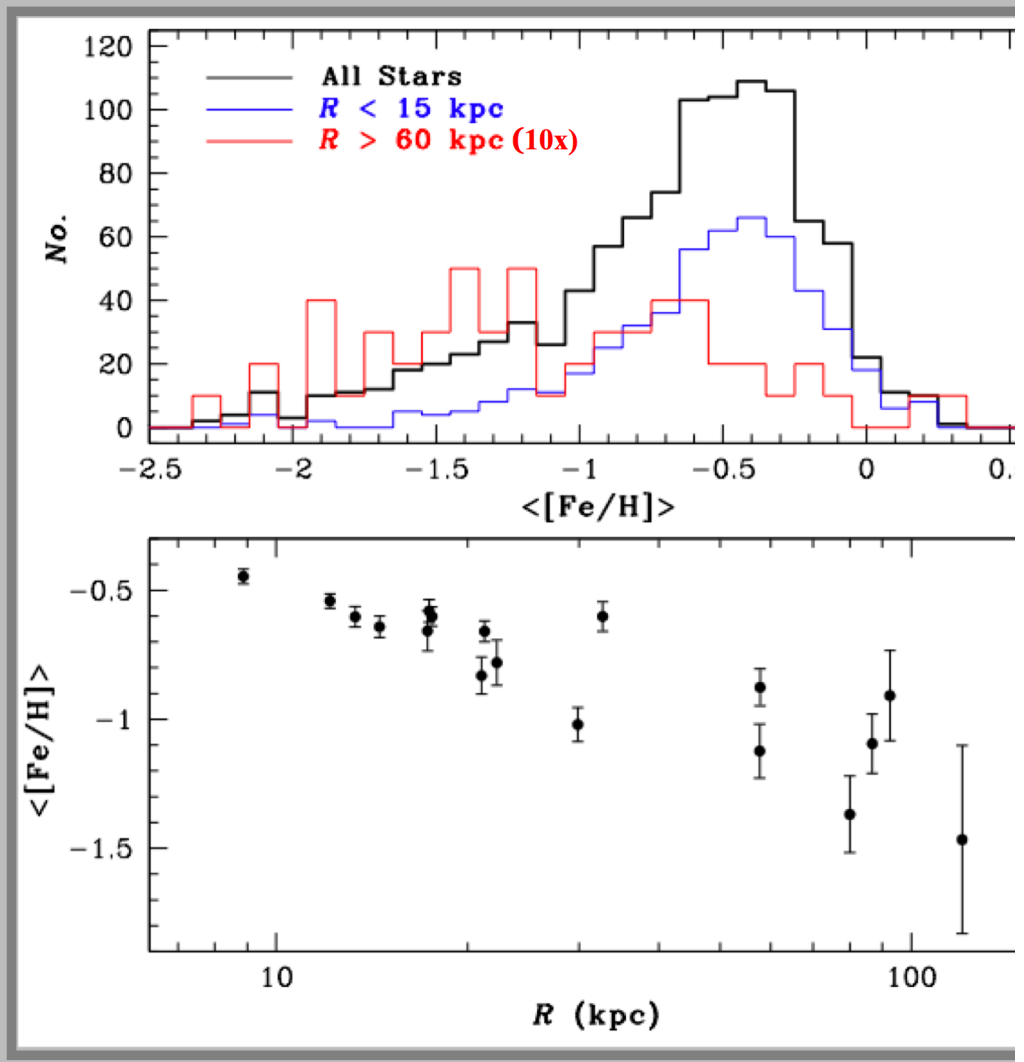

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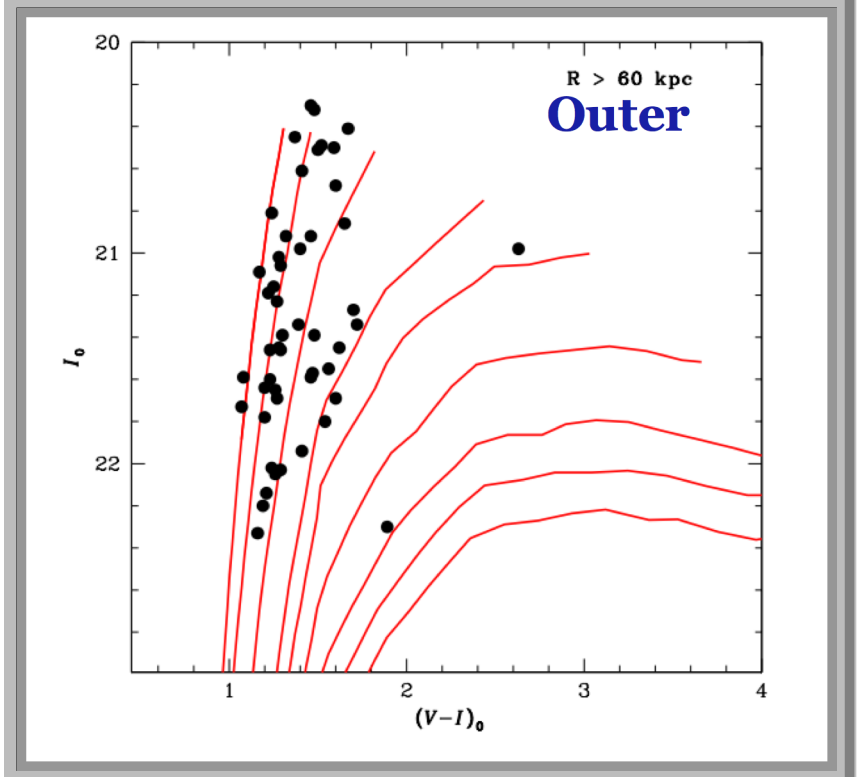

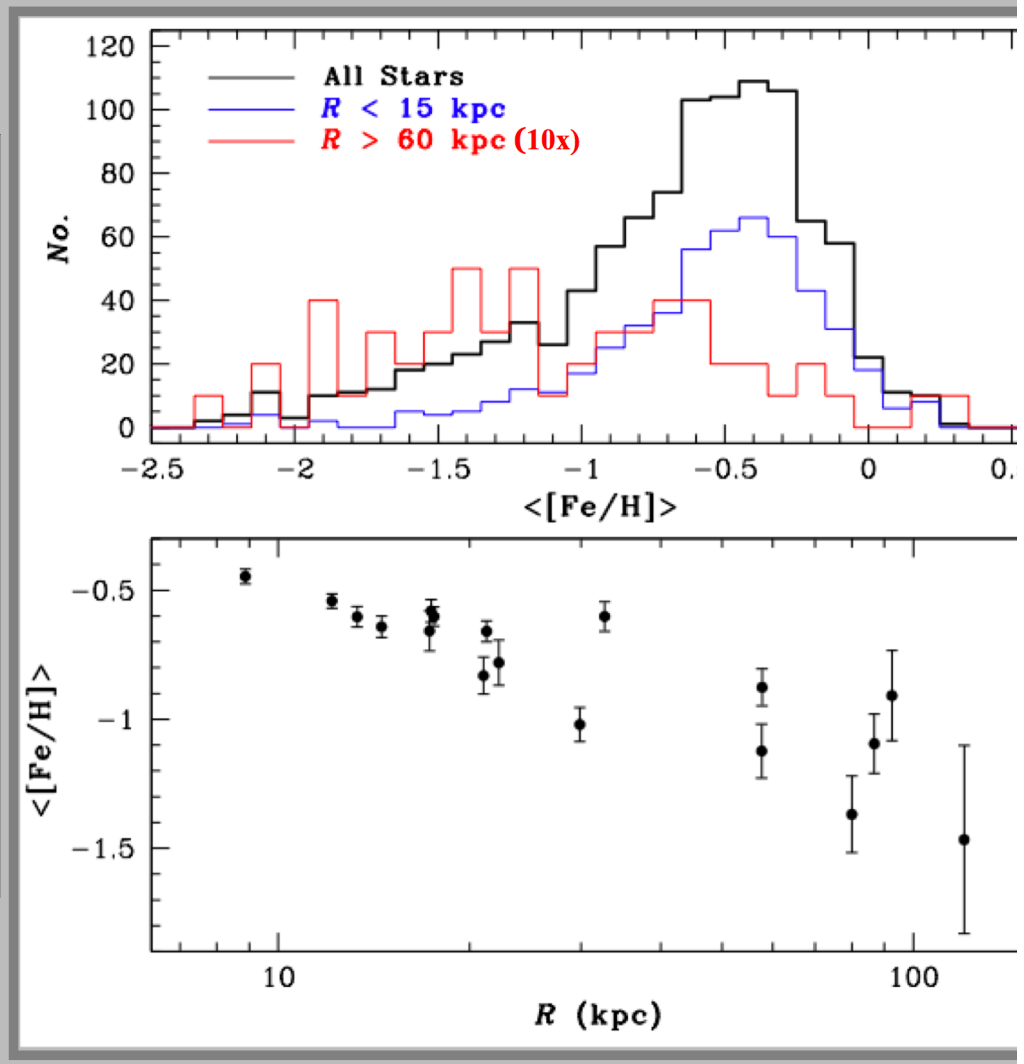

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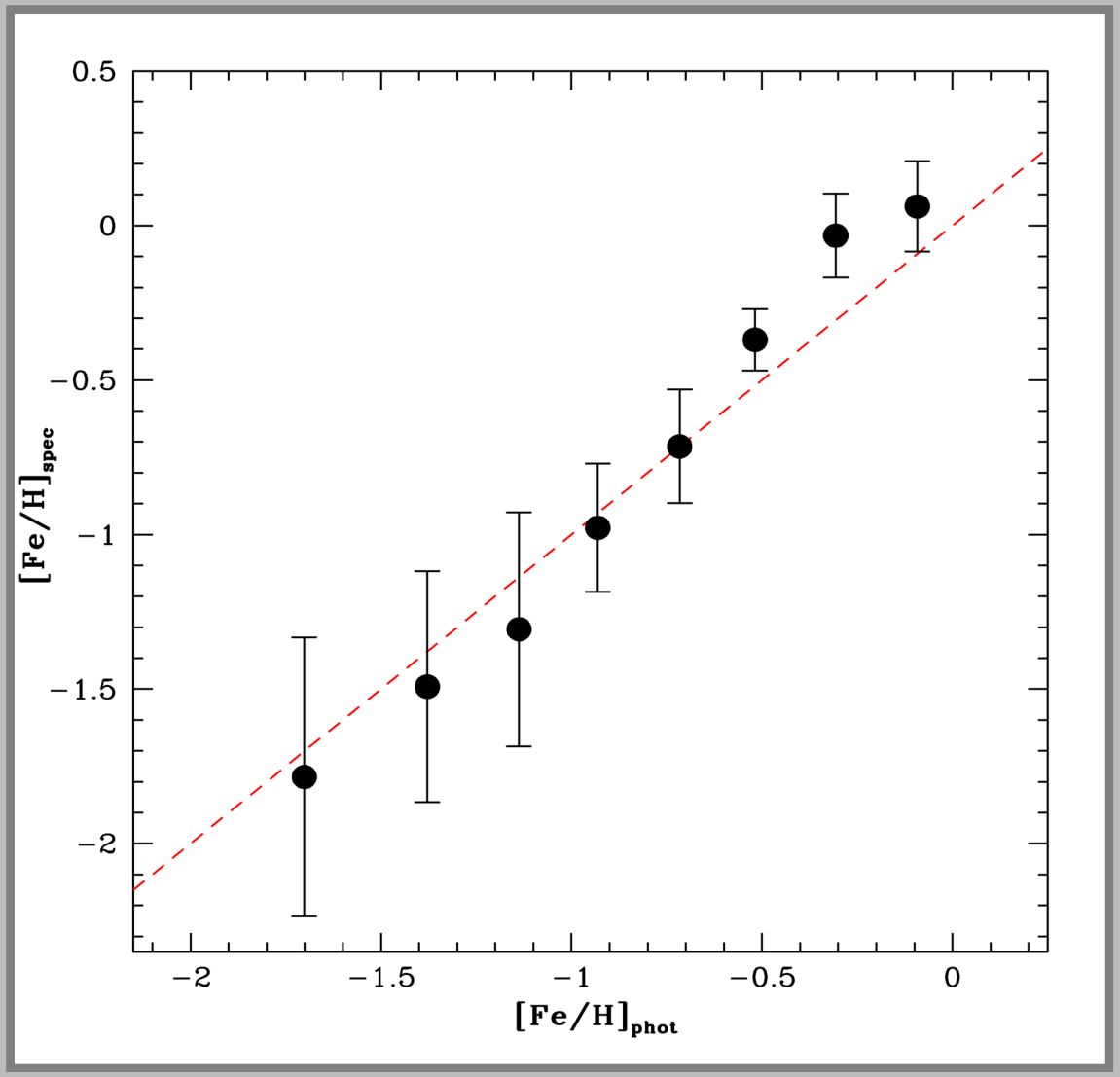
Photometric vs. Spectroscopic [Fe/H] Estimates



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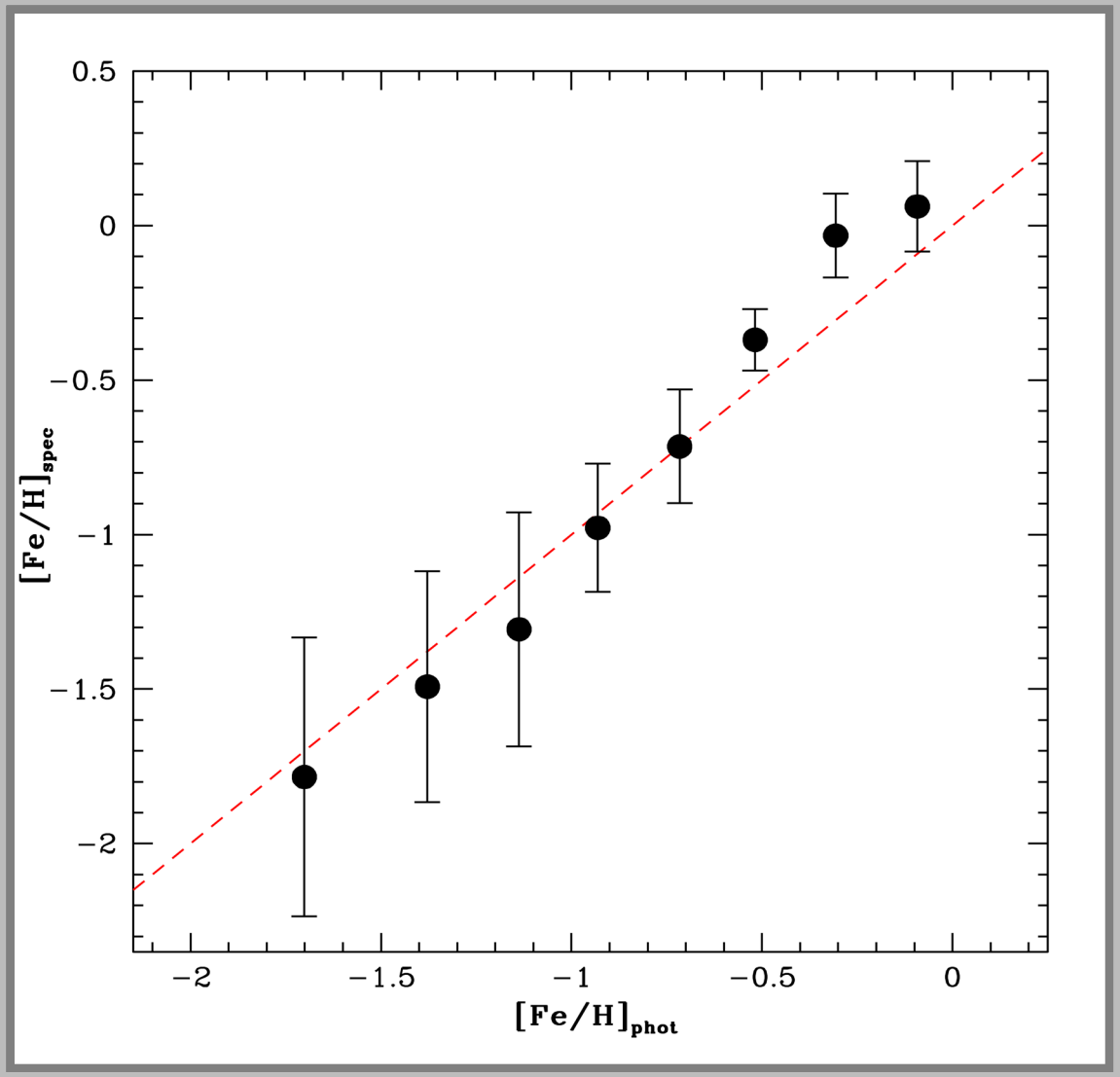

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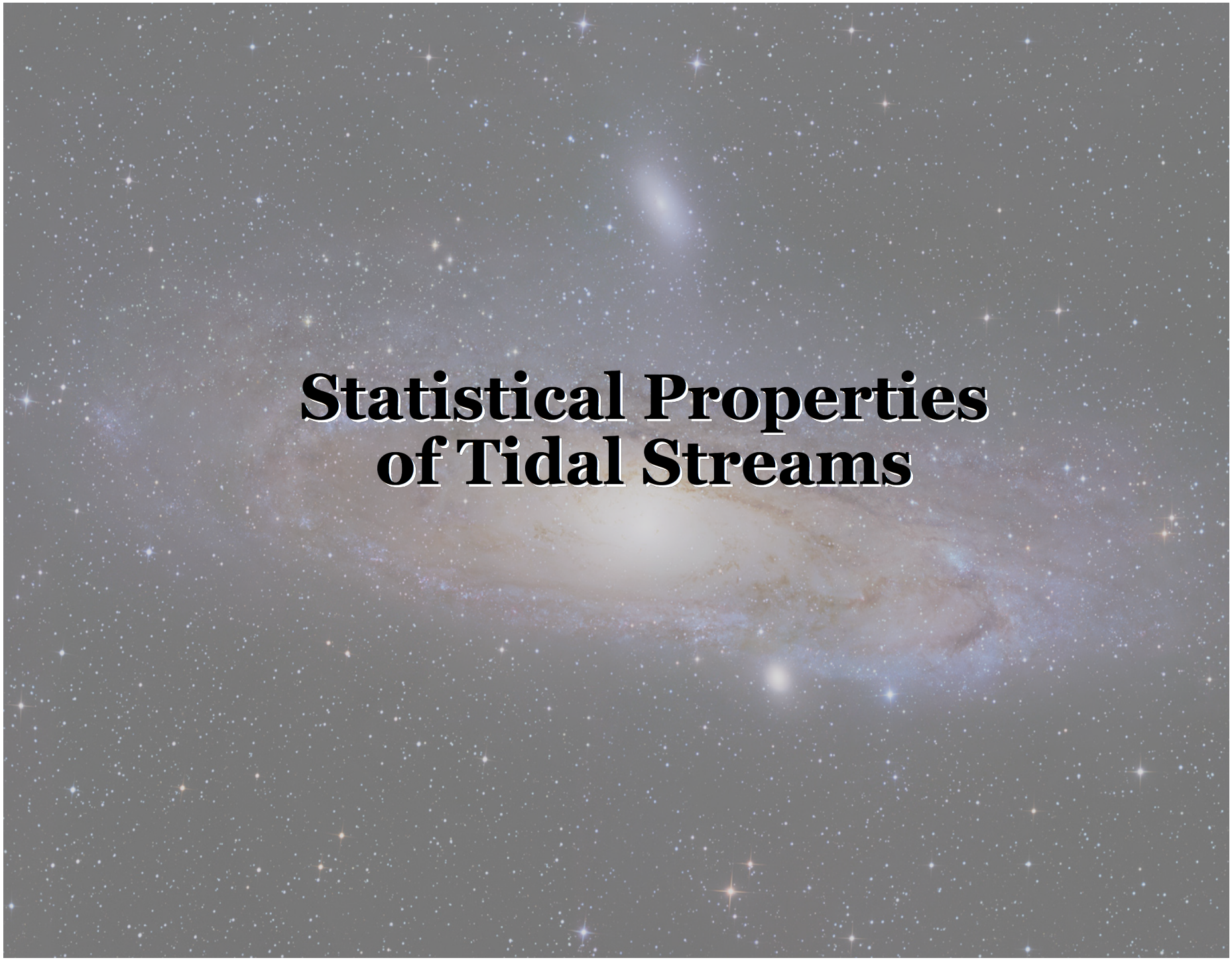
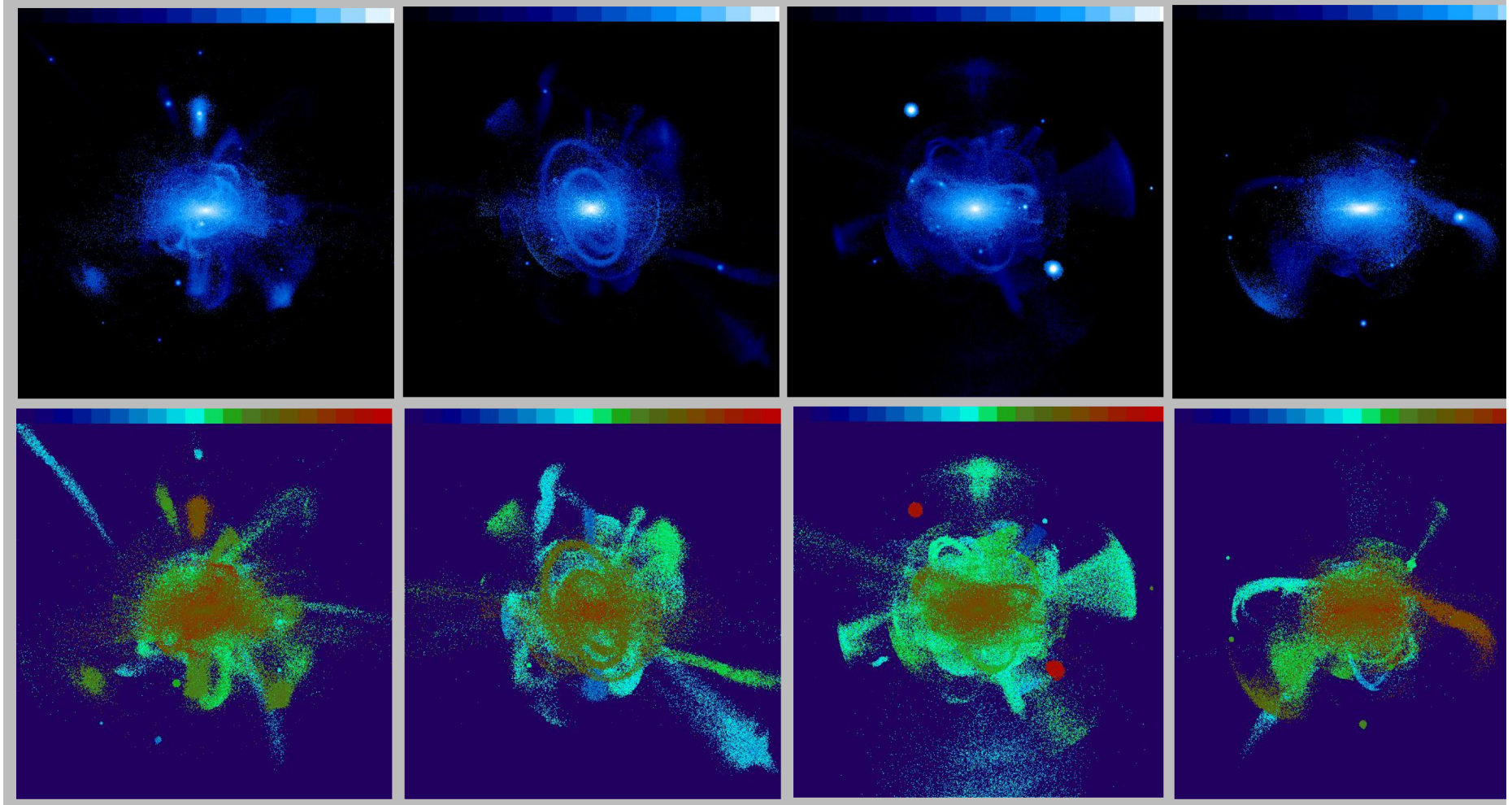
It is reassuring to see that there is a reasonably good correlation between the photometric and spectroscopic [Fe/H] estimates


Statistical Properties
of Tidal Streams

Simulations of the Formation of the Stellar Halo of MW/M31



Bullock & Johnston (2005) models

Font et al. (2008, Ap
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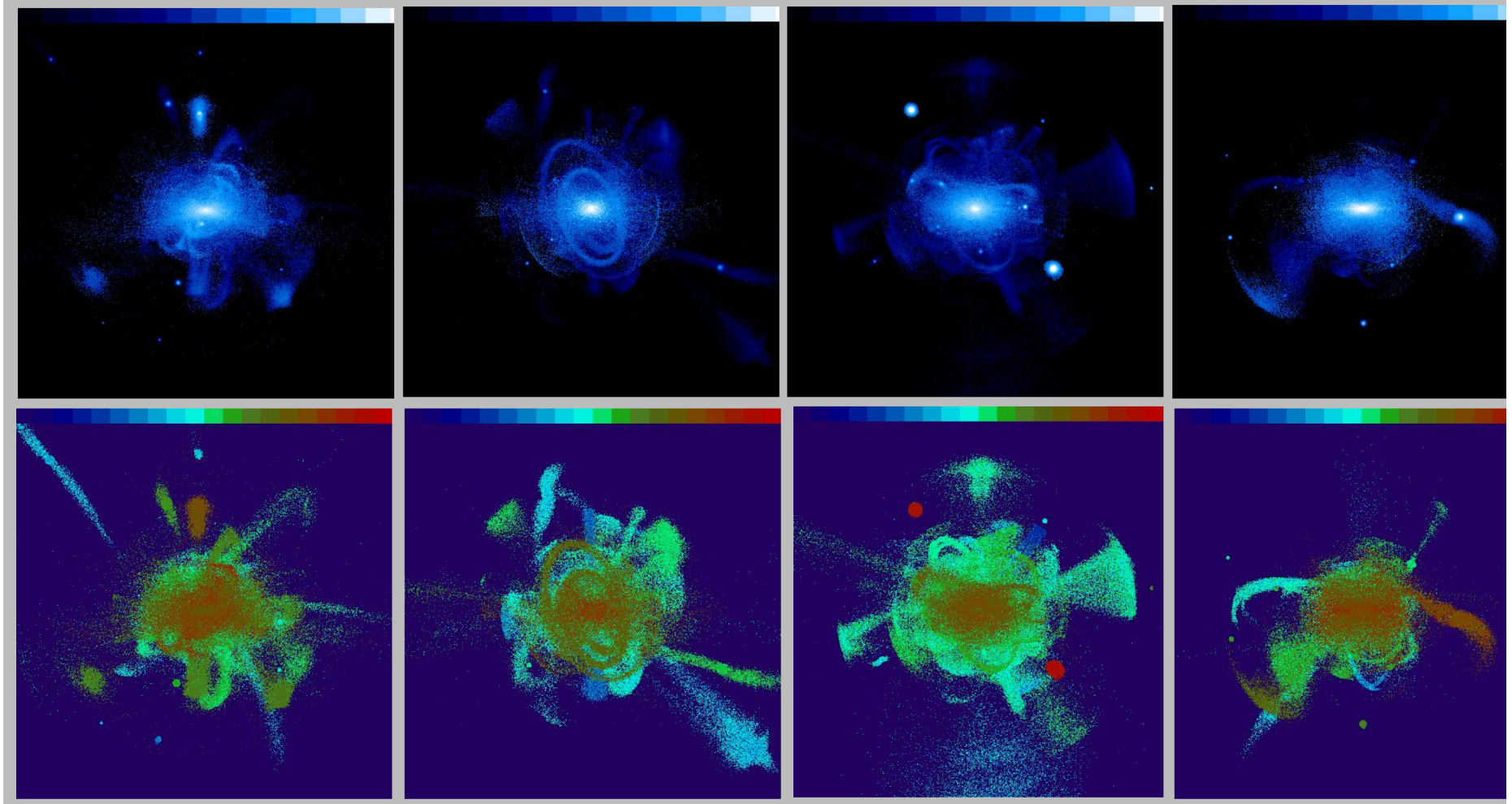

- Higher SB tidal debris tend to be more metal rich: observations and simulations
- Higher SB debris tend to come from the more luminous, metal rich dwarf satellites and/or recent encounters

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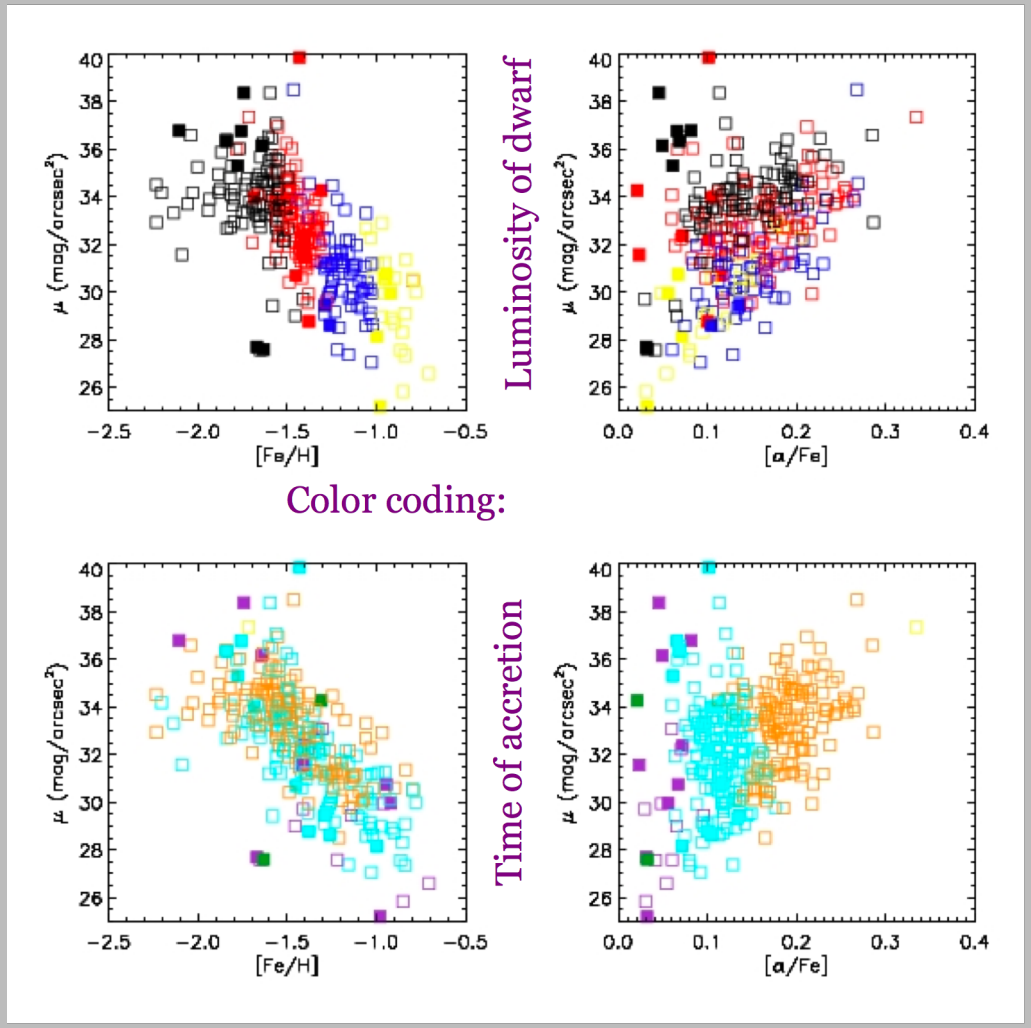
Metallicity and [α/Fe] of Tidal Streams

Bullock & Johnston (2005) mode



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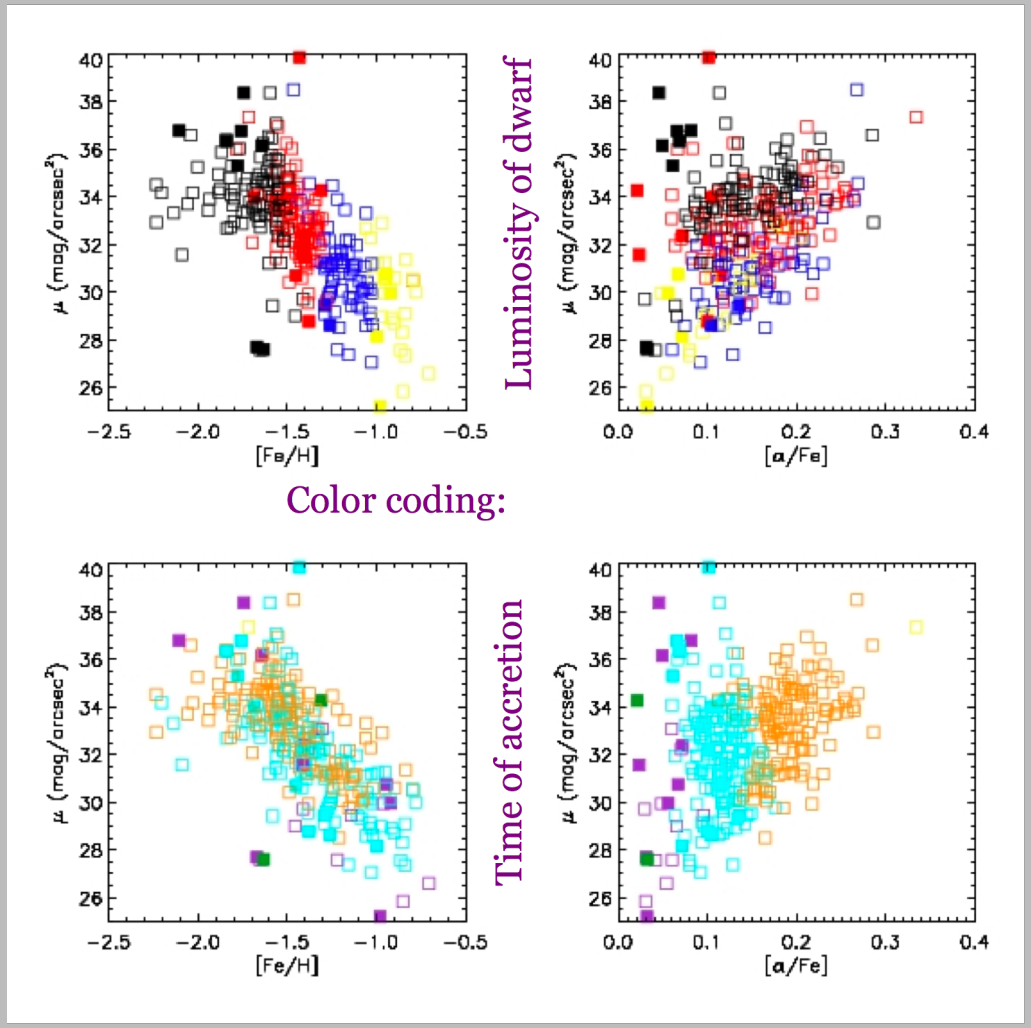

- Metallicity trend is related to luminosity of dwarf satellite progenitor
- Trend in [α/Fe] is related to time of accretion event

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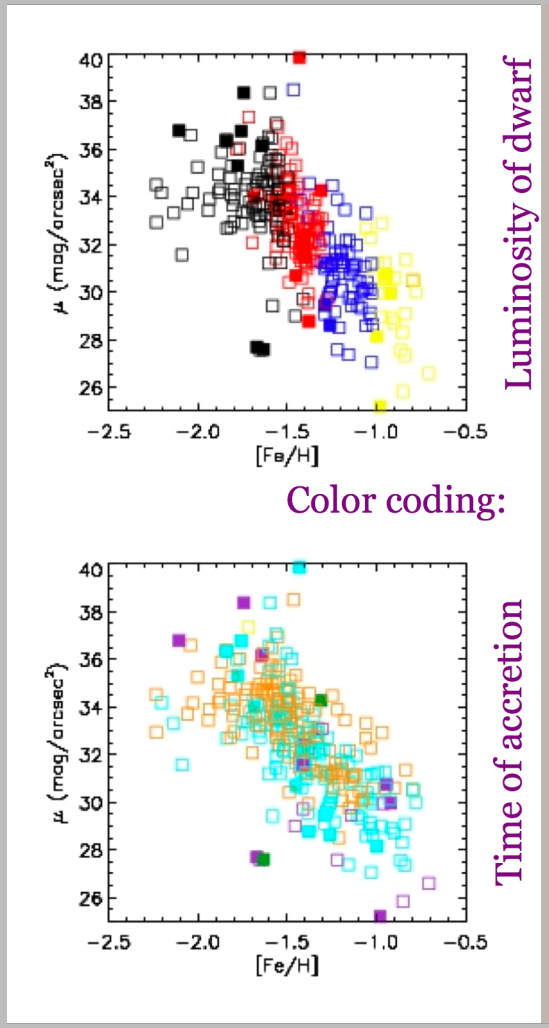

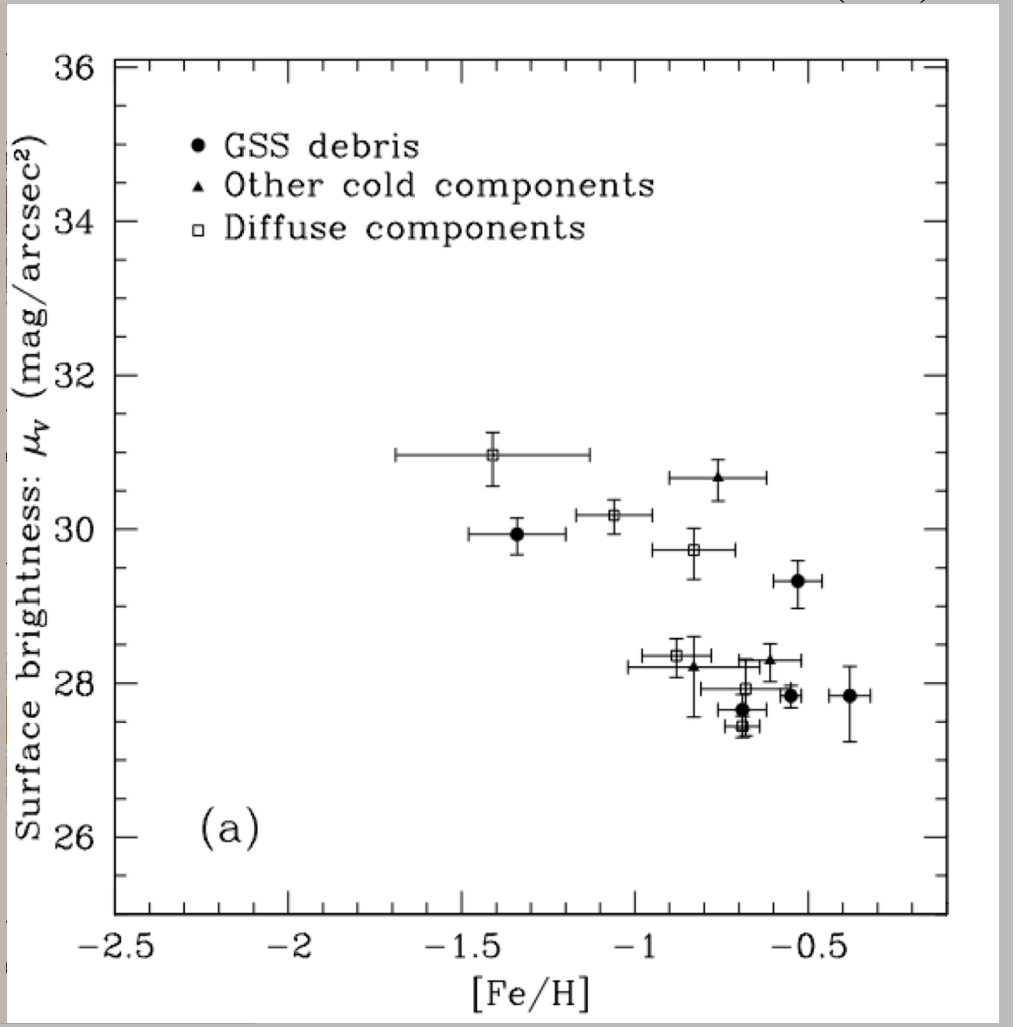

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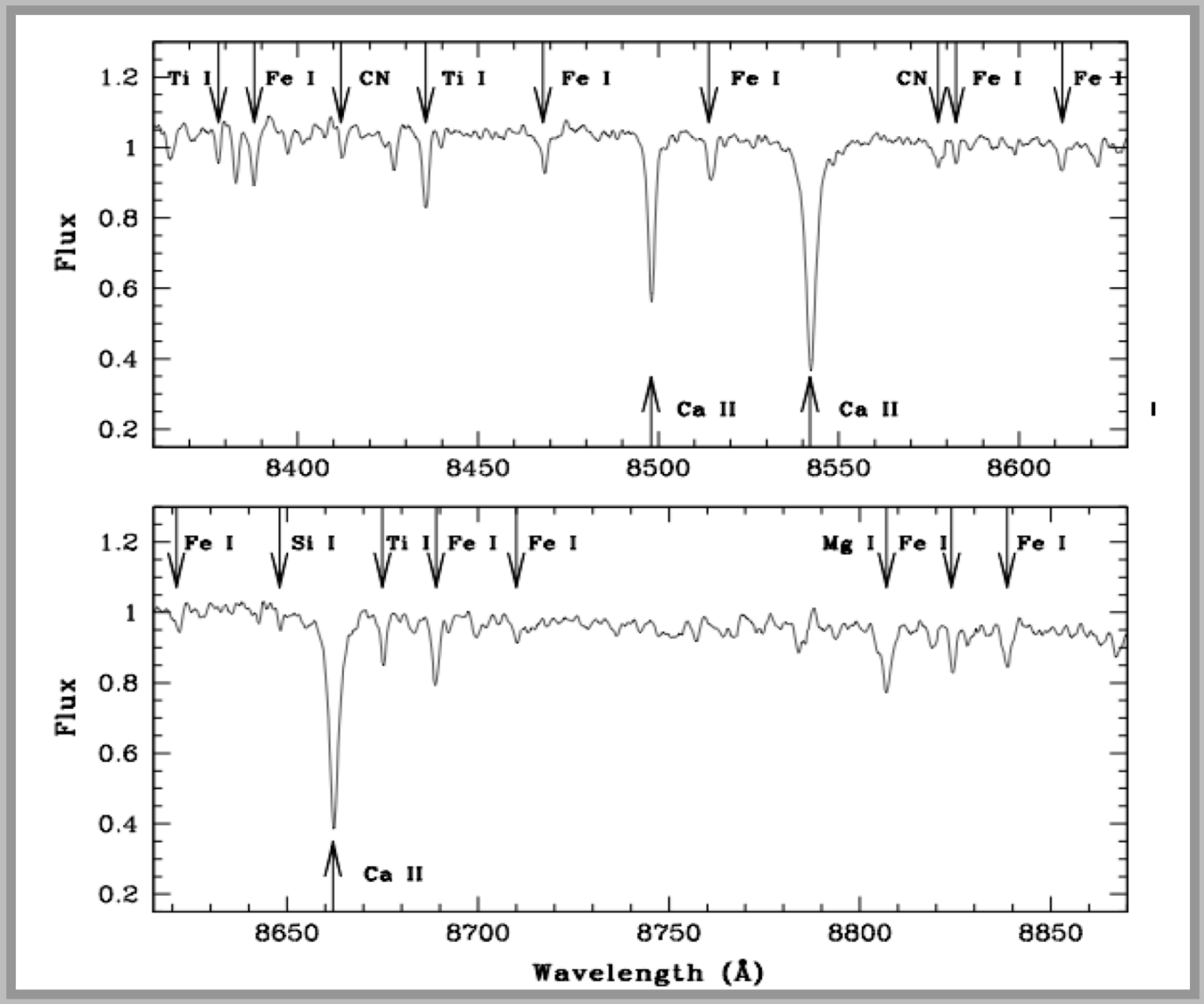
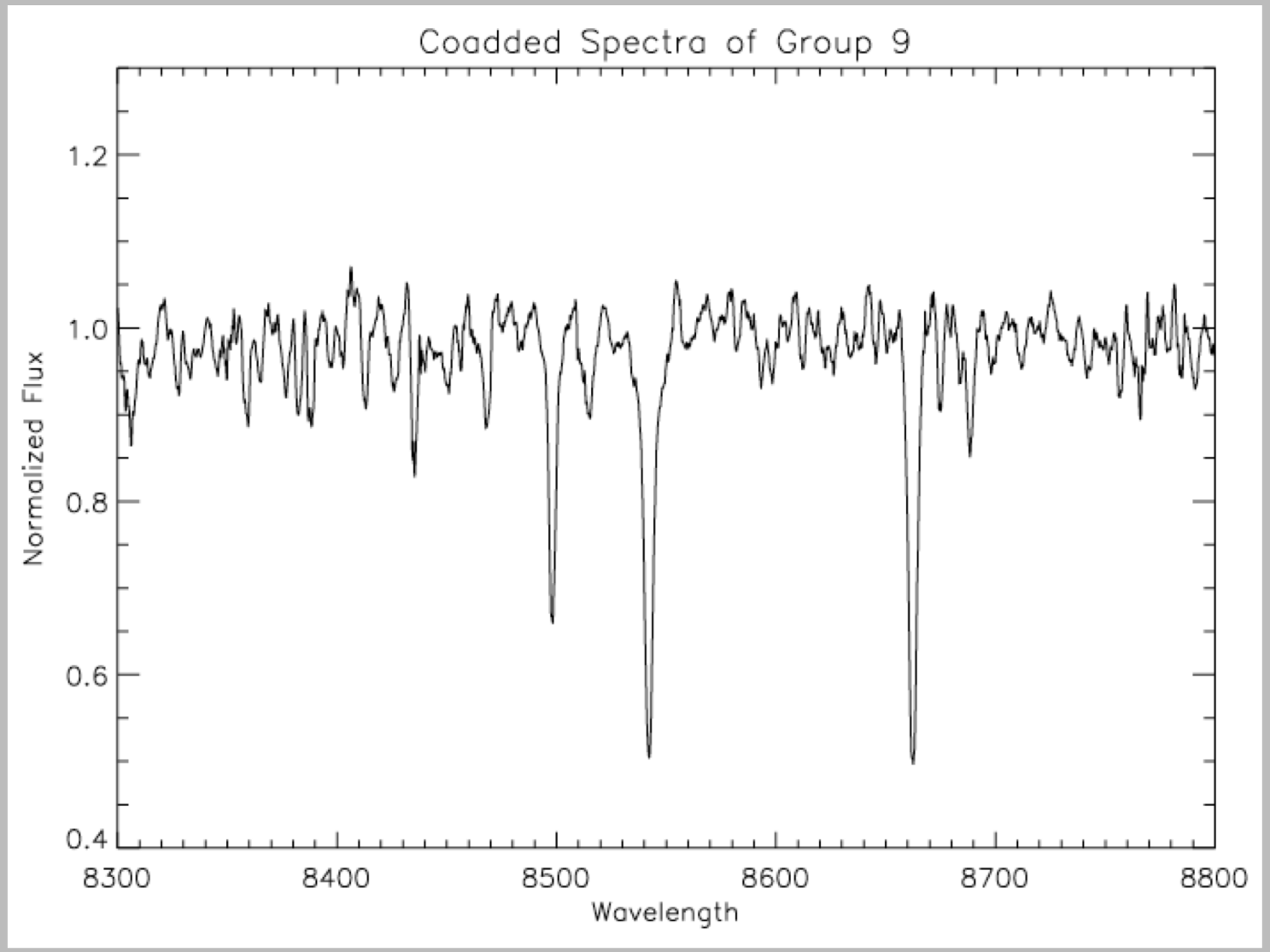
Detailed Chemical Abundance Analysis based on Co-added Spectra



Co-added Spectra of RGB Stars in NGC 147



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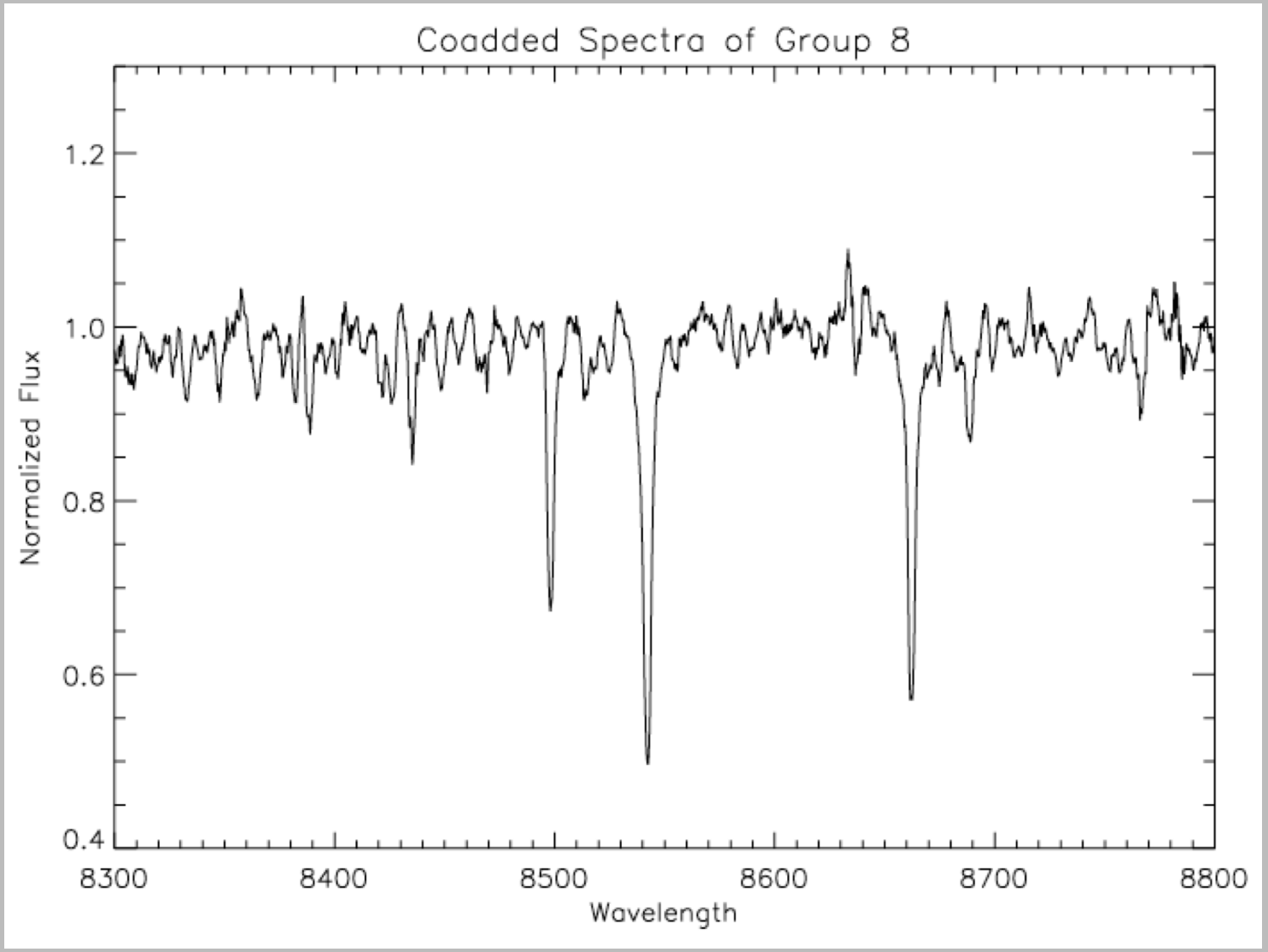

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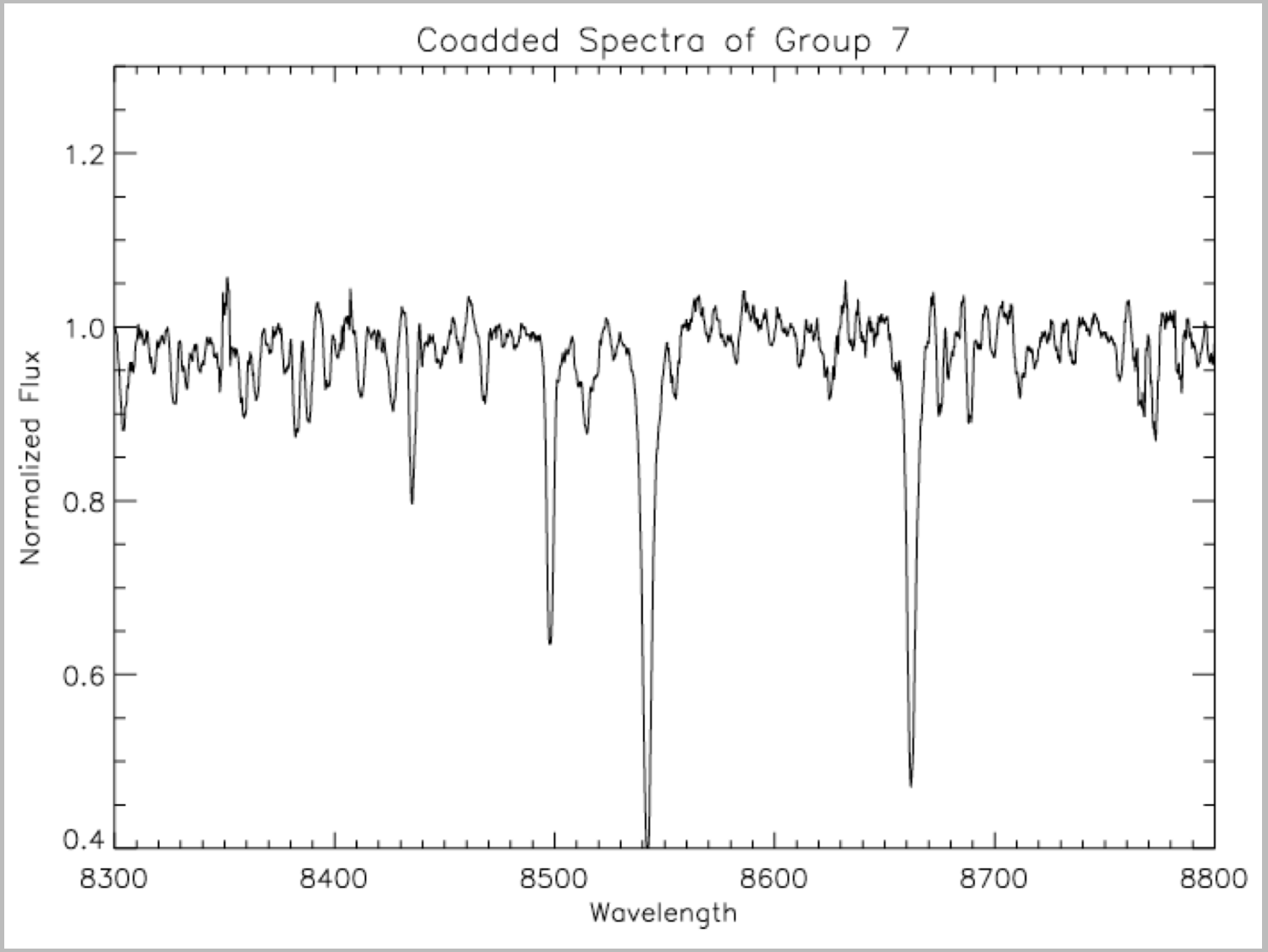

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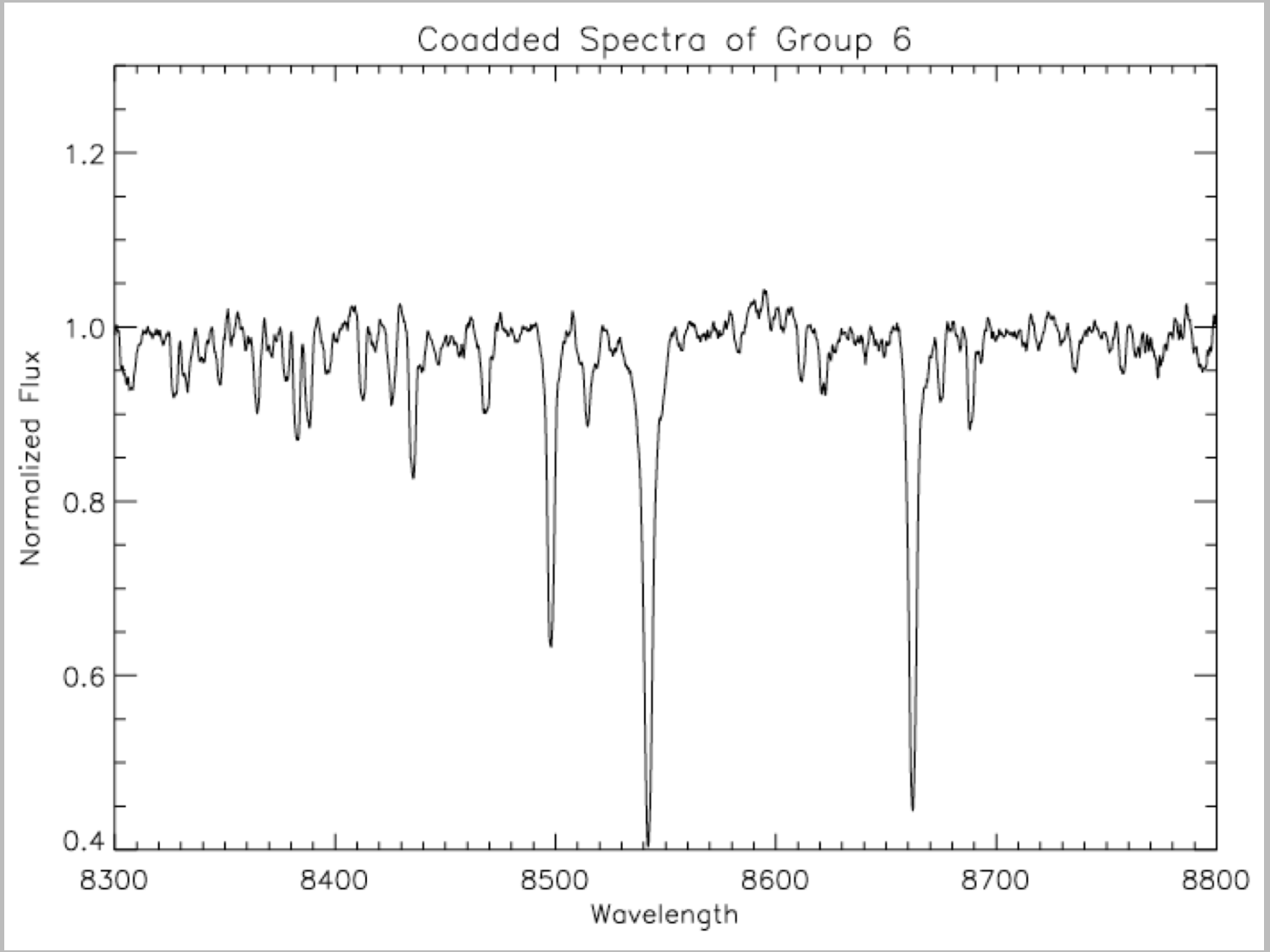

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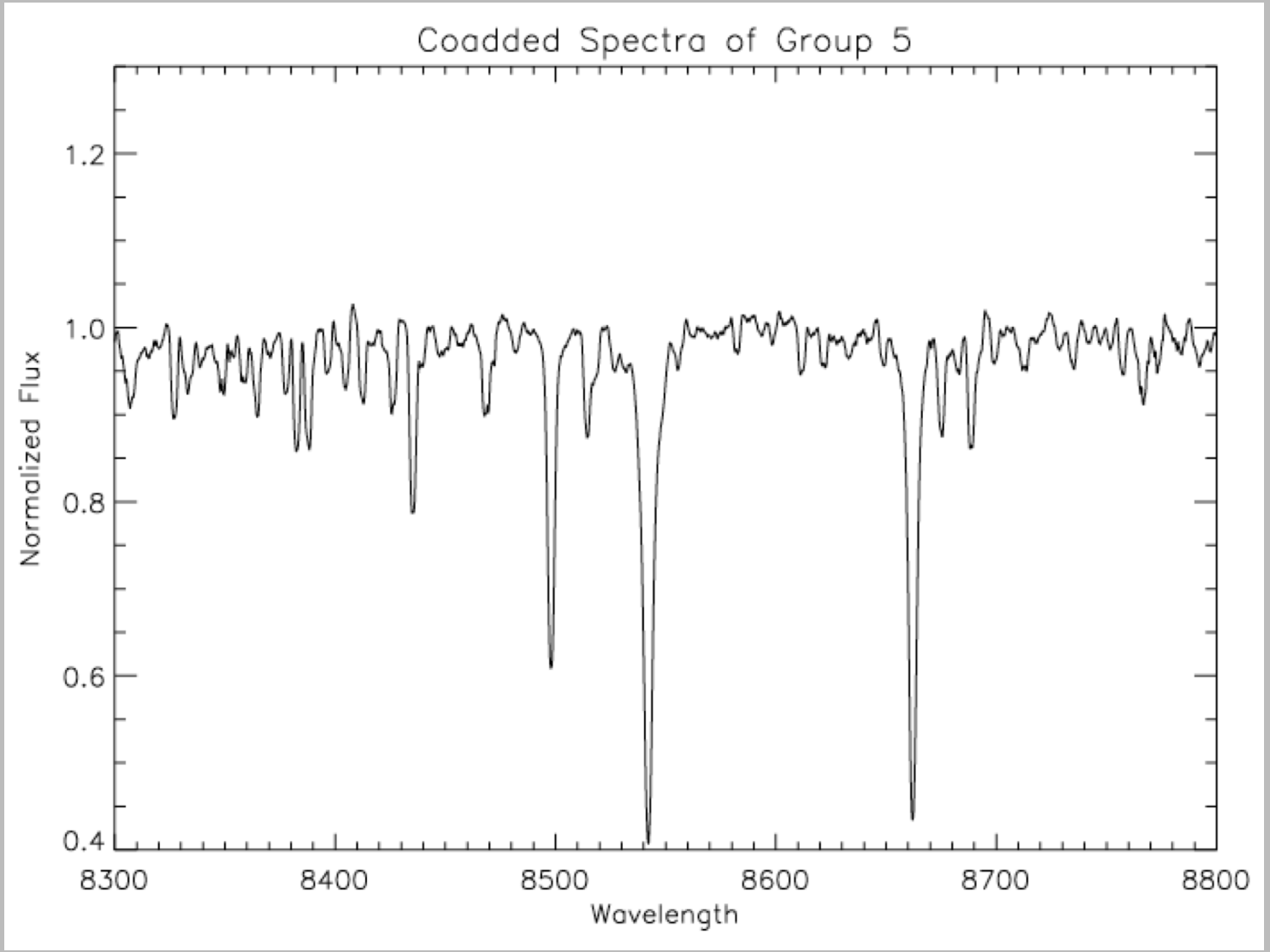

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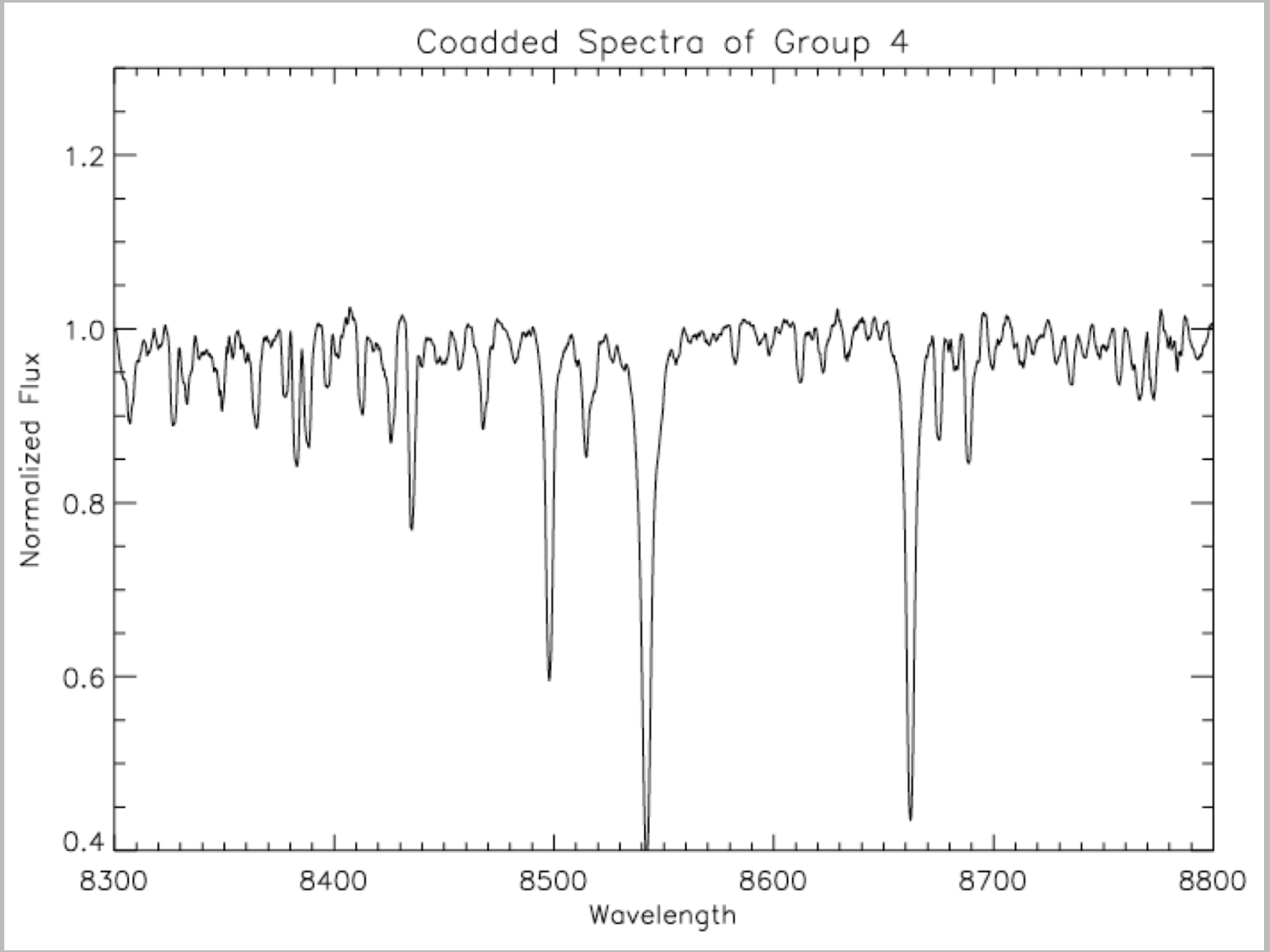

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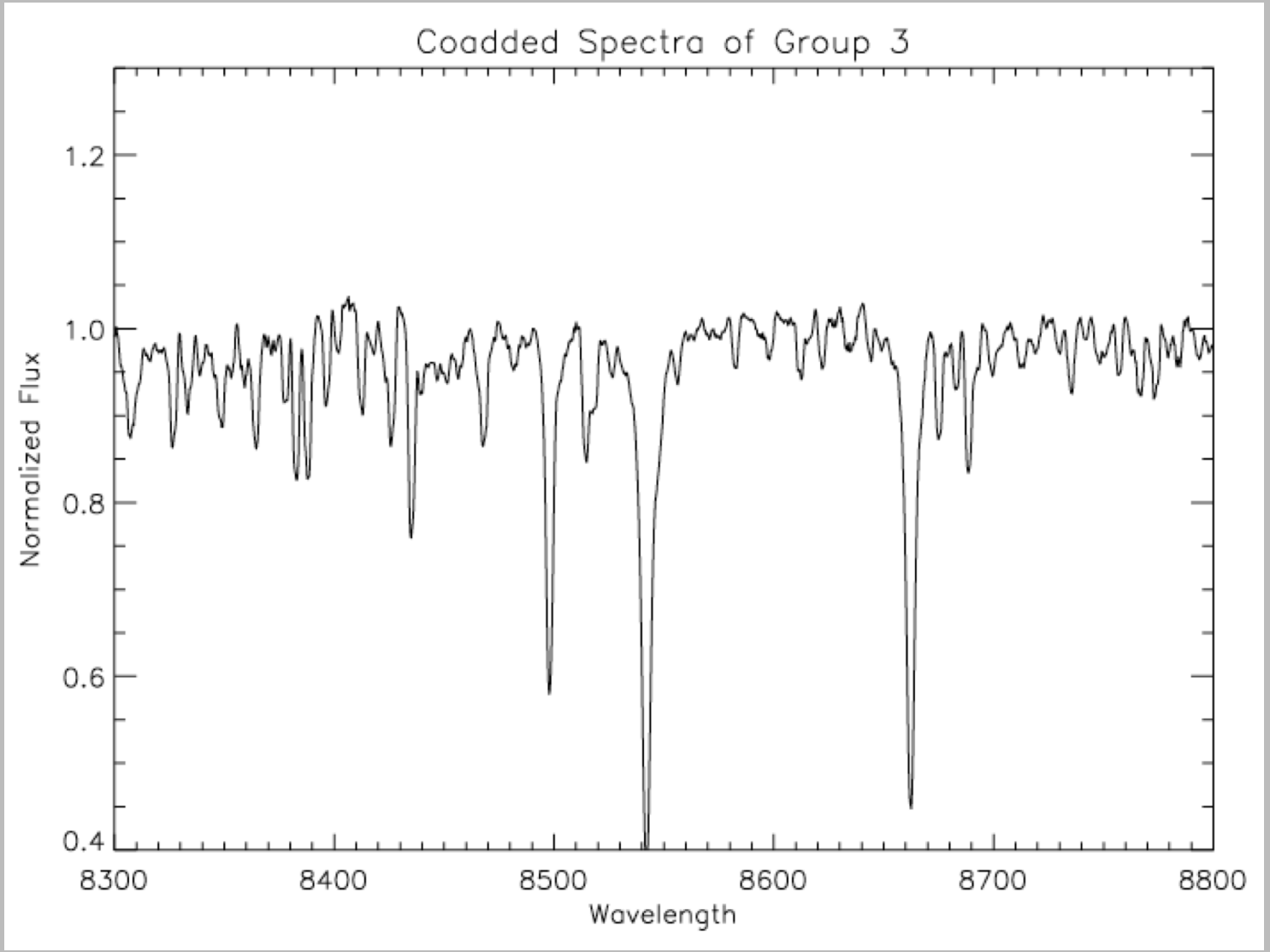

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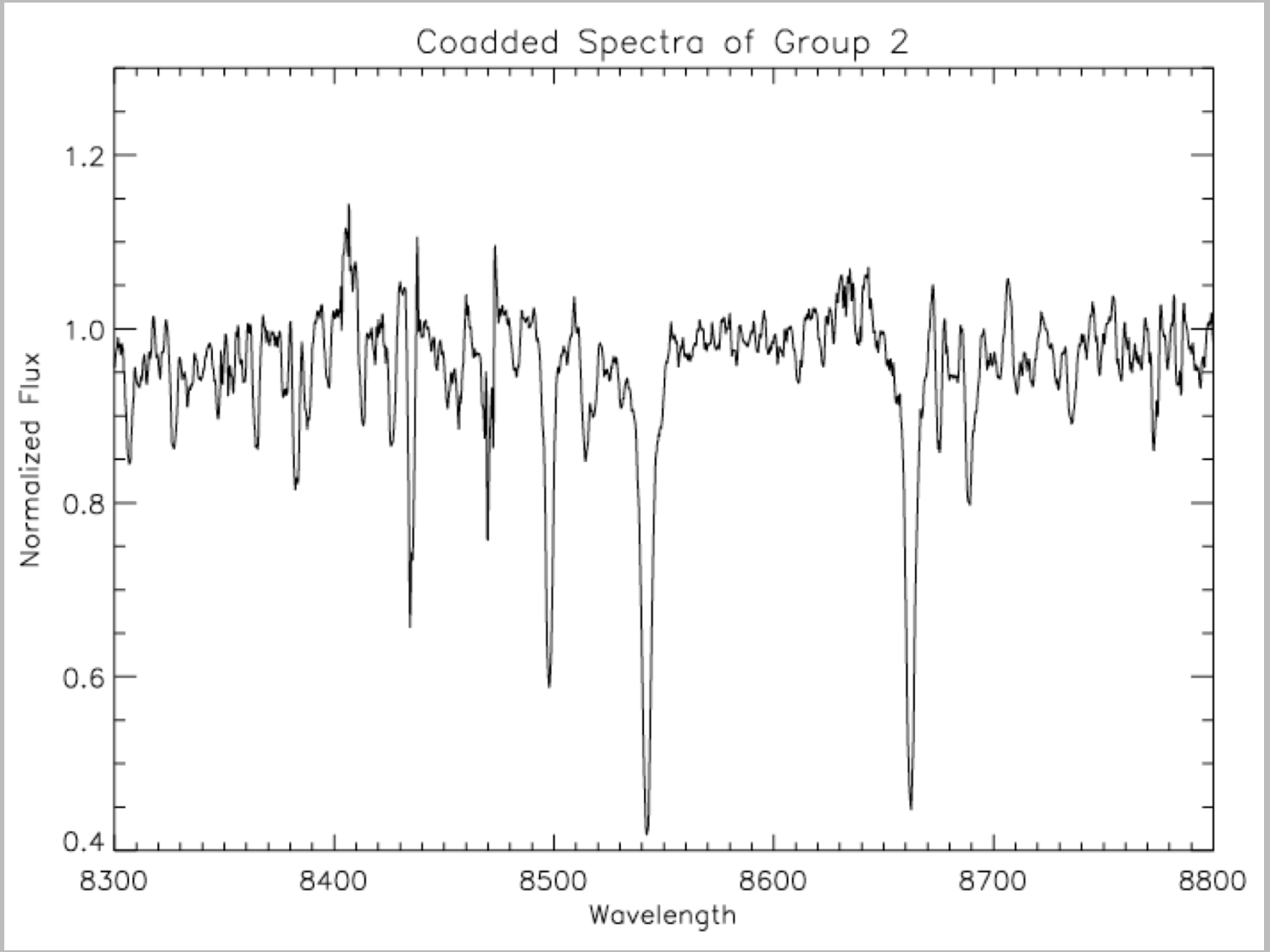

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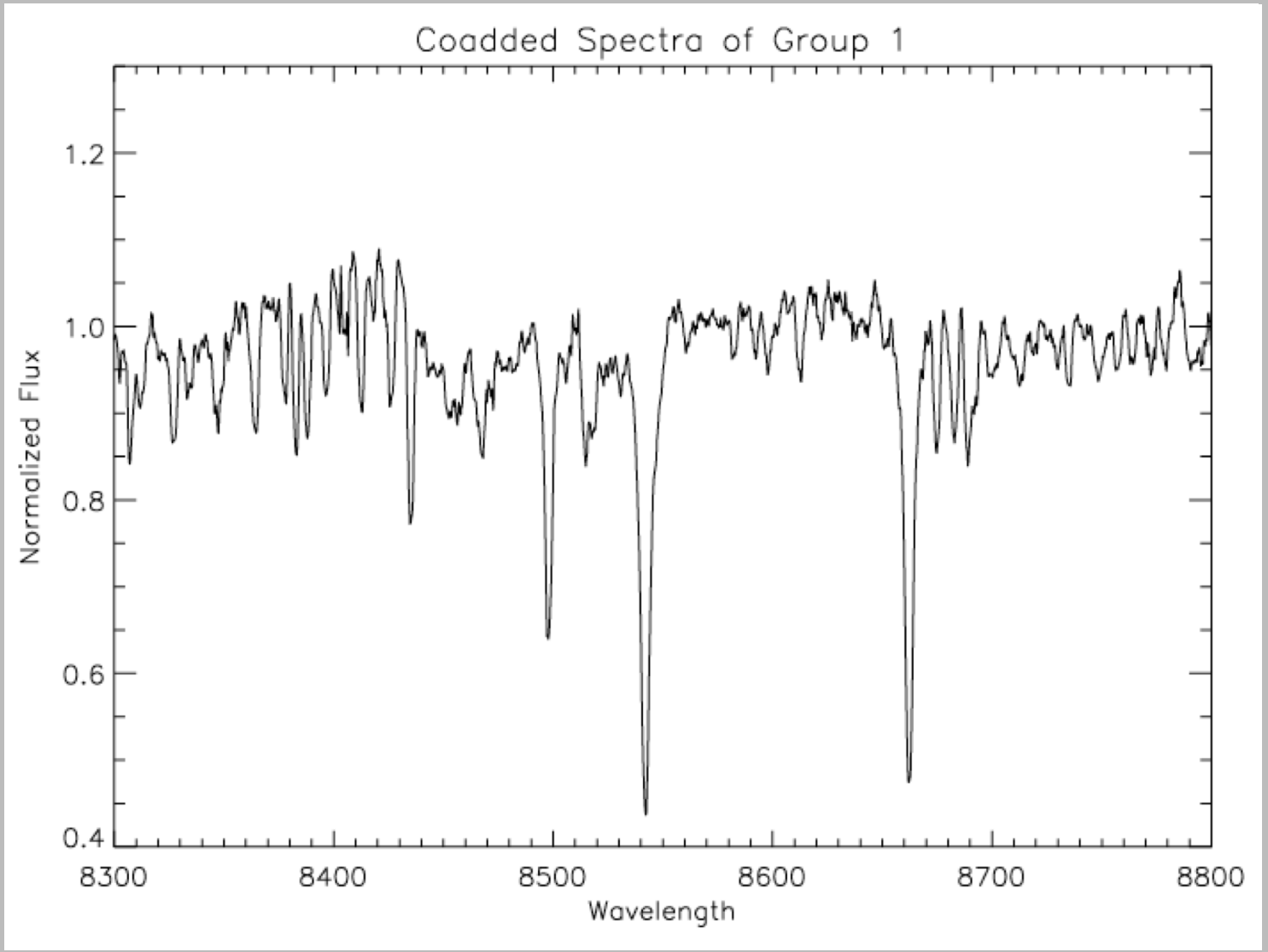

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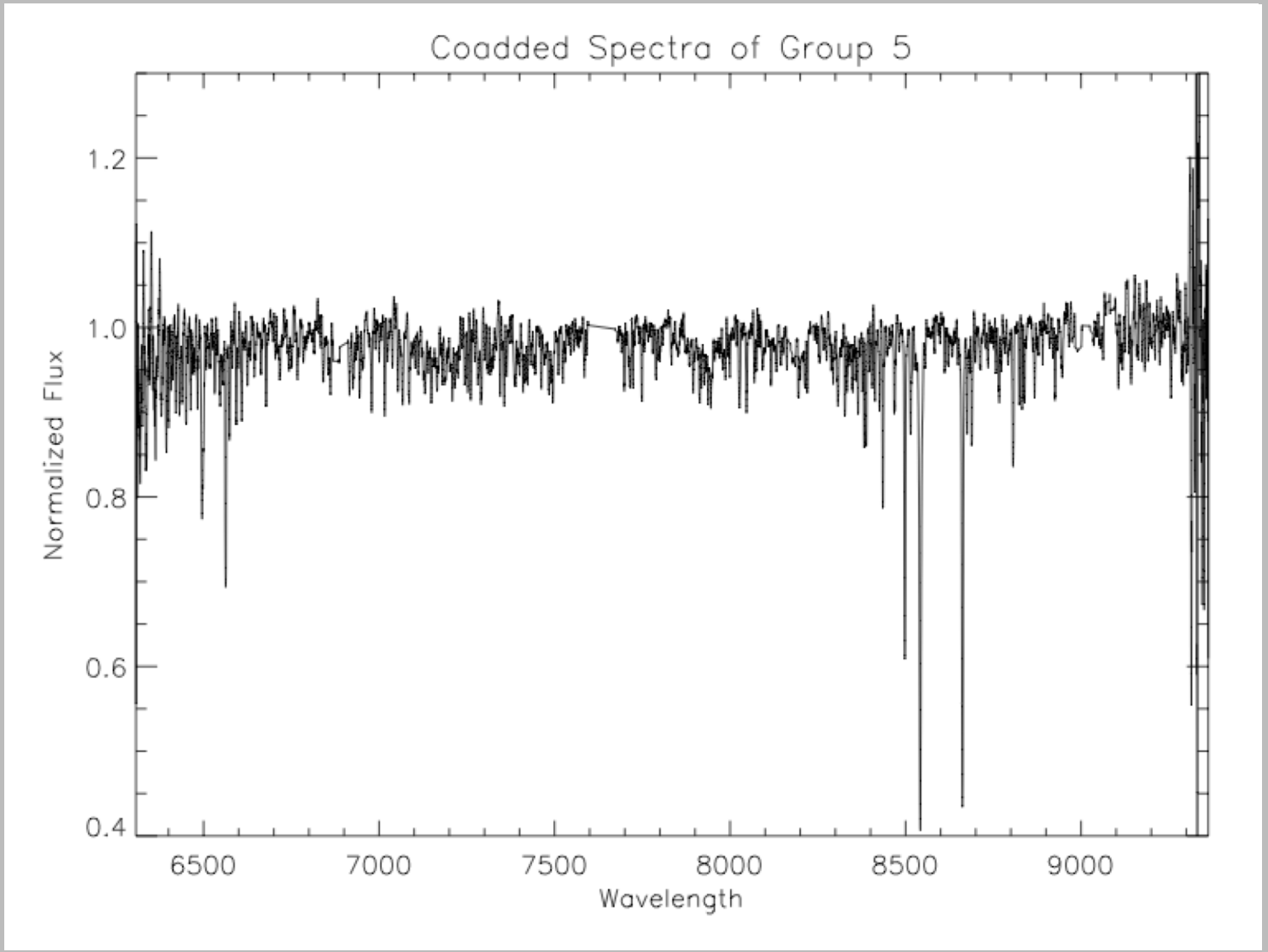

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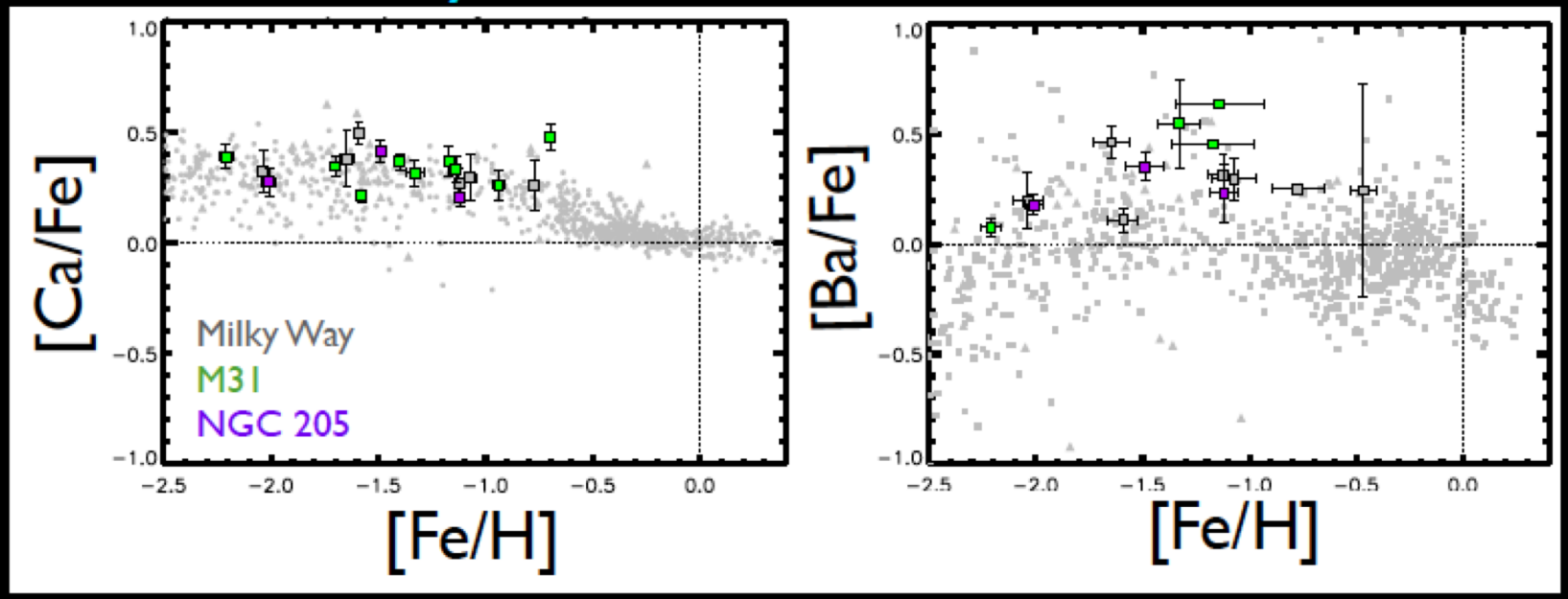
Integrated Light Spectroscopy of M31 GCs

Chemical Evolution Beyond the Milky Way with Globular Clusters



- Detailed chemical abundances of over 20 elements from high resolution, integrated light spectra of GCs
- Many similarities in [X/Fe] for the most massive galaxies in the Local Group!

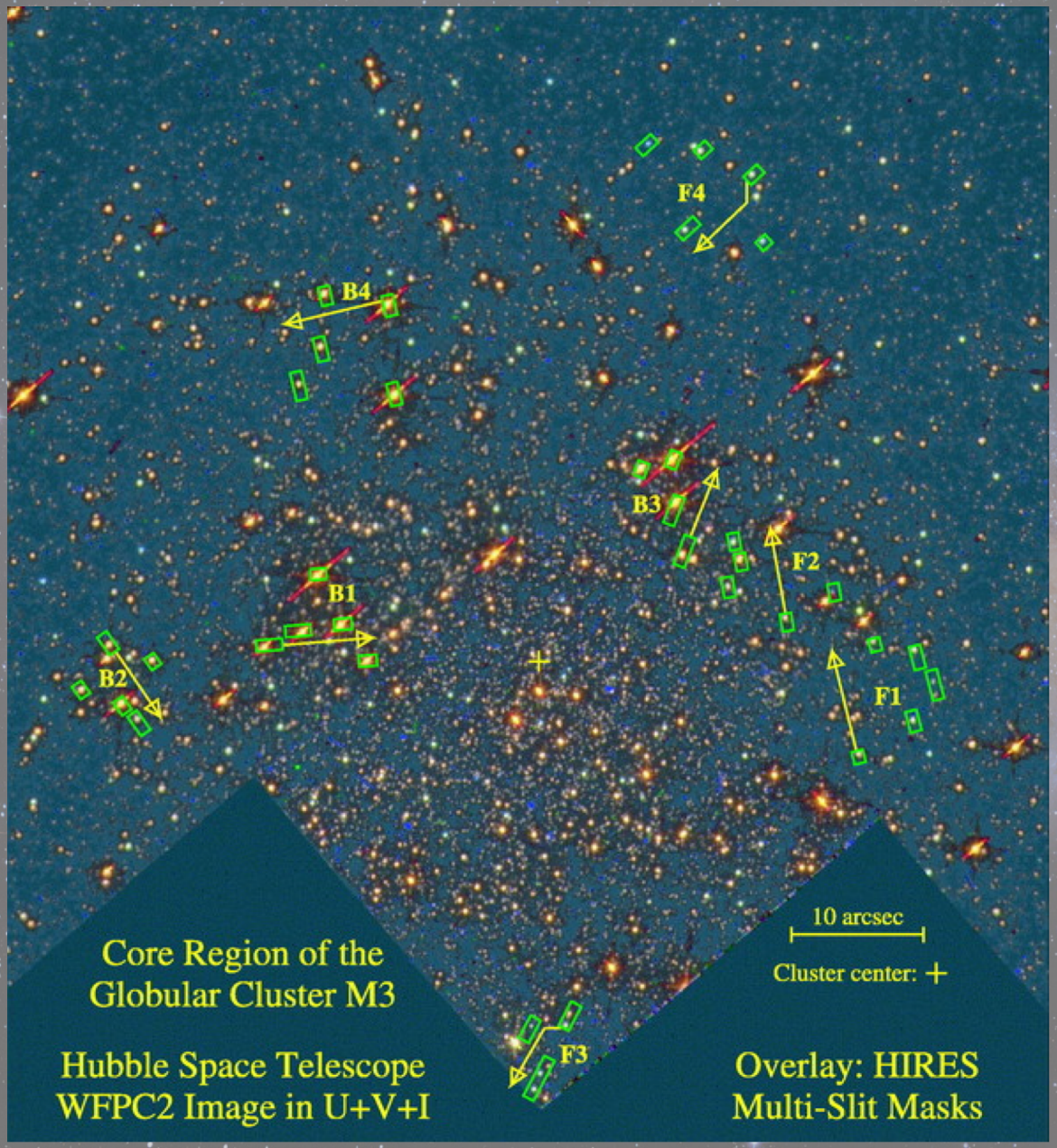
Colucci, Bernstein, McWilliam, Cameron & Cohen (2009, 2011)
Colucci, Bernstein, & McWilliam (2010) arXiv 1009.4195

Summary

Andromeda: A laboratory for the study of the interplay among the assembly history, dynamical history, star formation history, and chemical enrichment history of the structural subcomponents of spiral galaxies

Future prospects: Next-generation optical/IR telescopes will enable us to obtain spectra of individual stars out to the M81 group (few Mpc: D^2 increase) and possibly even the Virgo Cluster (20 Mpc: D^4 increase)

Multi-slit HIRES Spectroscopy



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