

Prospects for Local Group and Local Volume studies with TMT

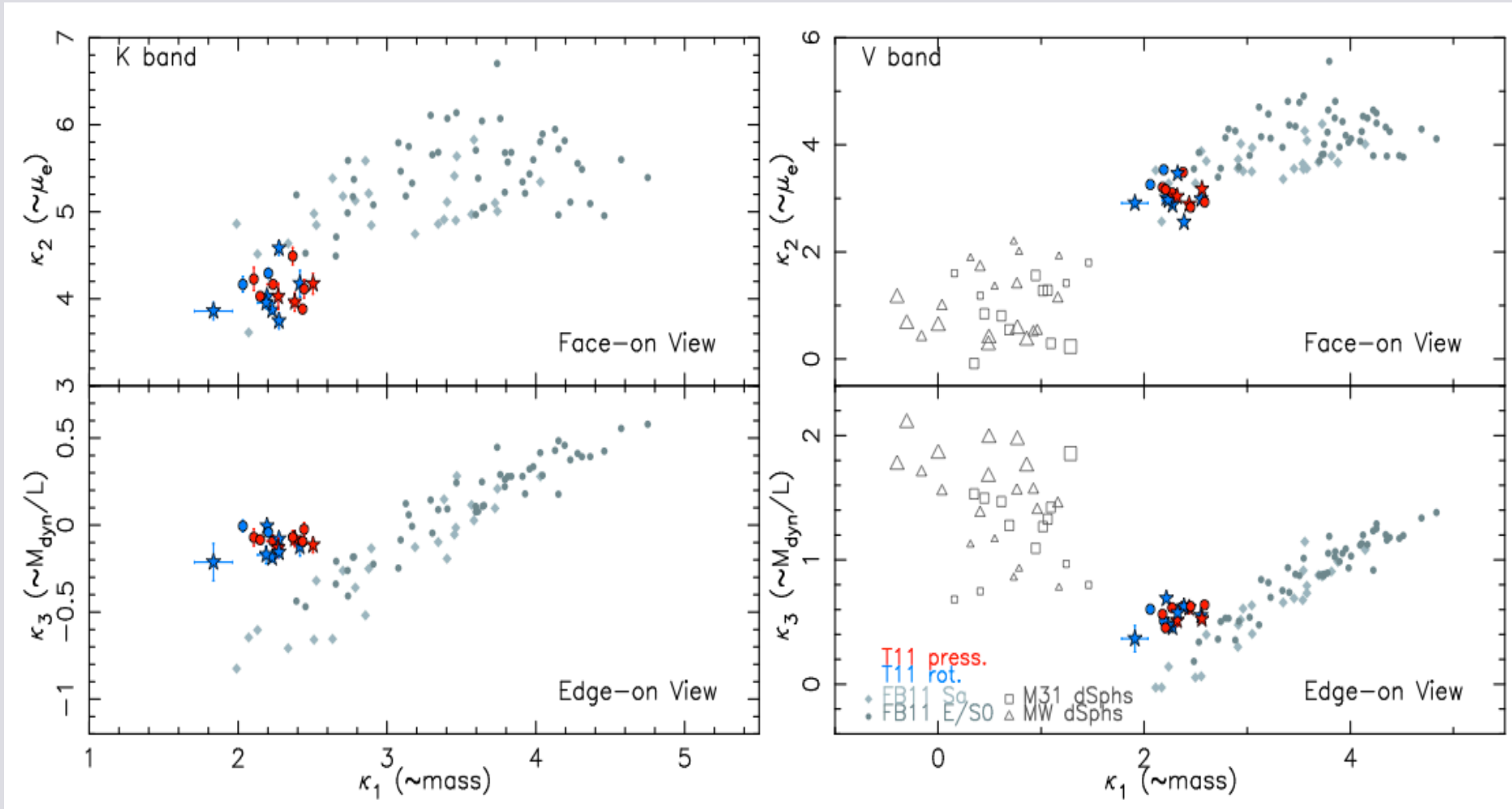
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Examples of what TMT can do for Local Group / Local Volume science

- ❖ Do dwarf elliptical galaxies contain dark matter?
- ❖ Finding and measuring the masses of ultra-faint dwarf spheroidal galaxies in the Local Group – the smallest dark matter sub-halos
- ❖ Characterizing the smallest of the dark matter sub-halos – constraints on baryonic physics
- ❖ Dust mapping of Andromeda's disk based on “thermometry” of M giant stars
- ❖ The gastronomical habits and mass of the Milky Way

Mass-to-light ratios of early-type galaxies of different masses



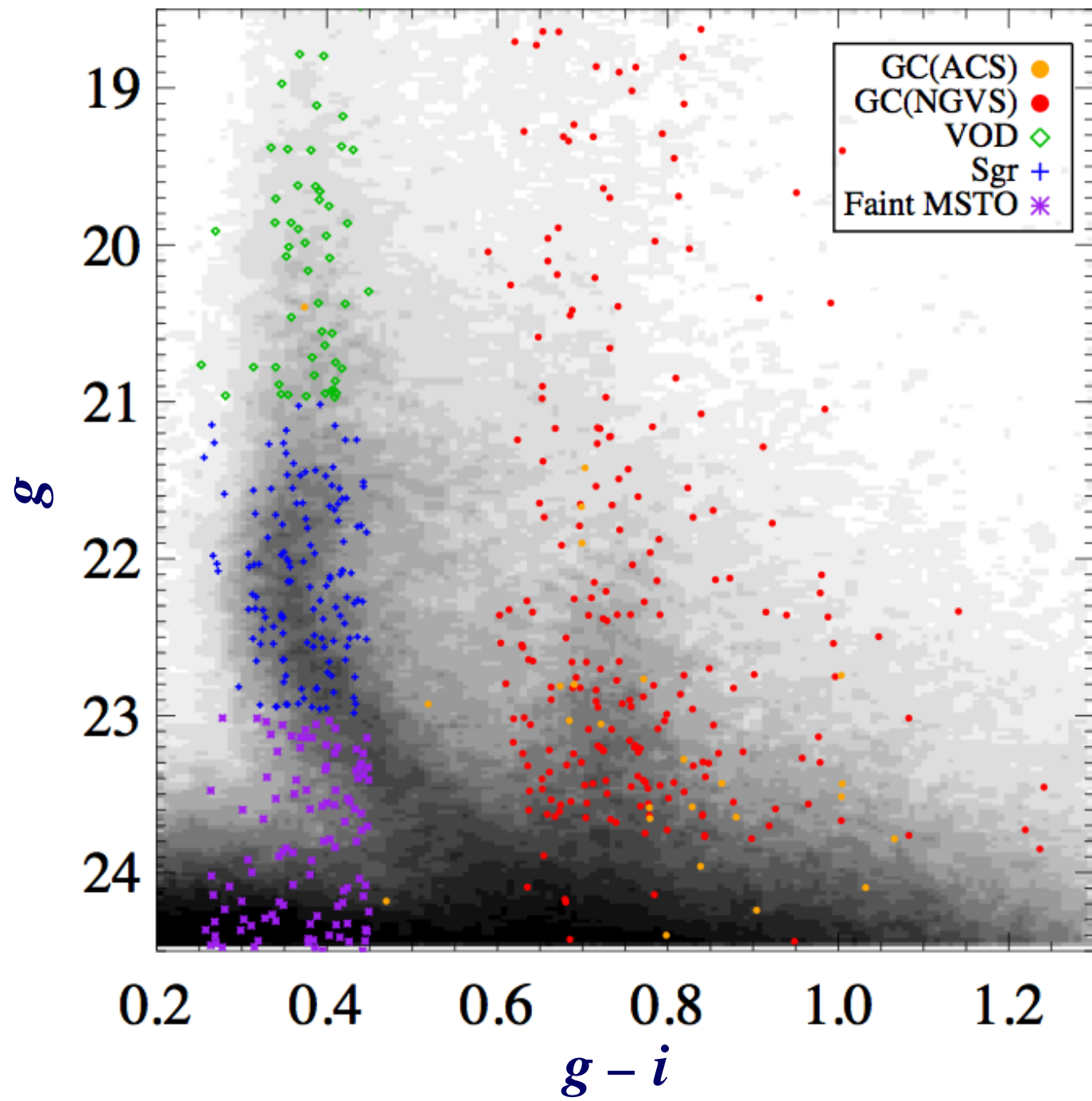
Virgo Cluster dEs: Integrated light kinematics measured out to $\sim 1 r_{\text{eff}}$

Local Group dEs: Resolved stellar kinematics measured out to $\sim 7-8 r_{\text{eff}}$

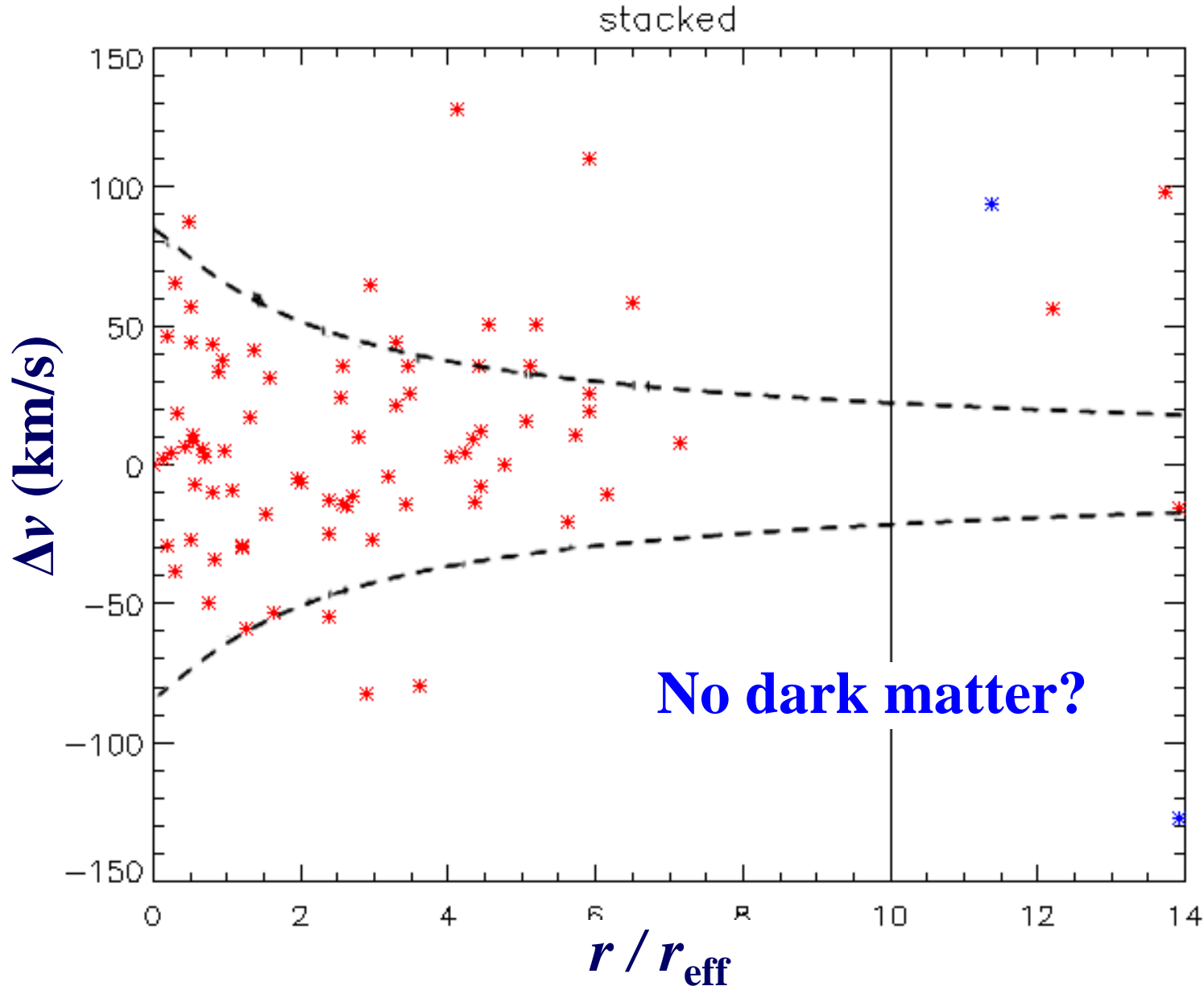
Inferred dynamical M/L ratios consistent stars alone

An experiment: Stacking globular cluster satellites of Virgo Cluster dwarf ellipticals

- We are targeting dEs that are low enough luminosity such that they each contain only a handful of GC satellites
- Photometric selection of GC satellites candidates using the Next Generation Virgo Survey (NGVS)
- Keck/DEIMOS spectroscopy of GC satellite candidates; TMT will go fainter than the peak of the GC luminosity function



Stack of GC satellites for 21 Virgo Cluster dwarf ellipticals

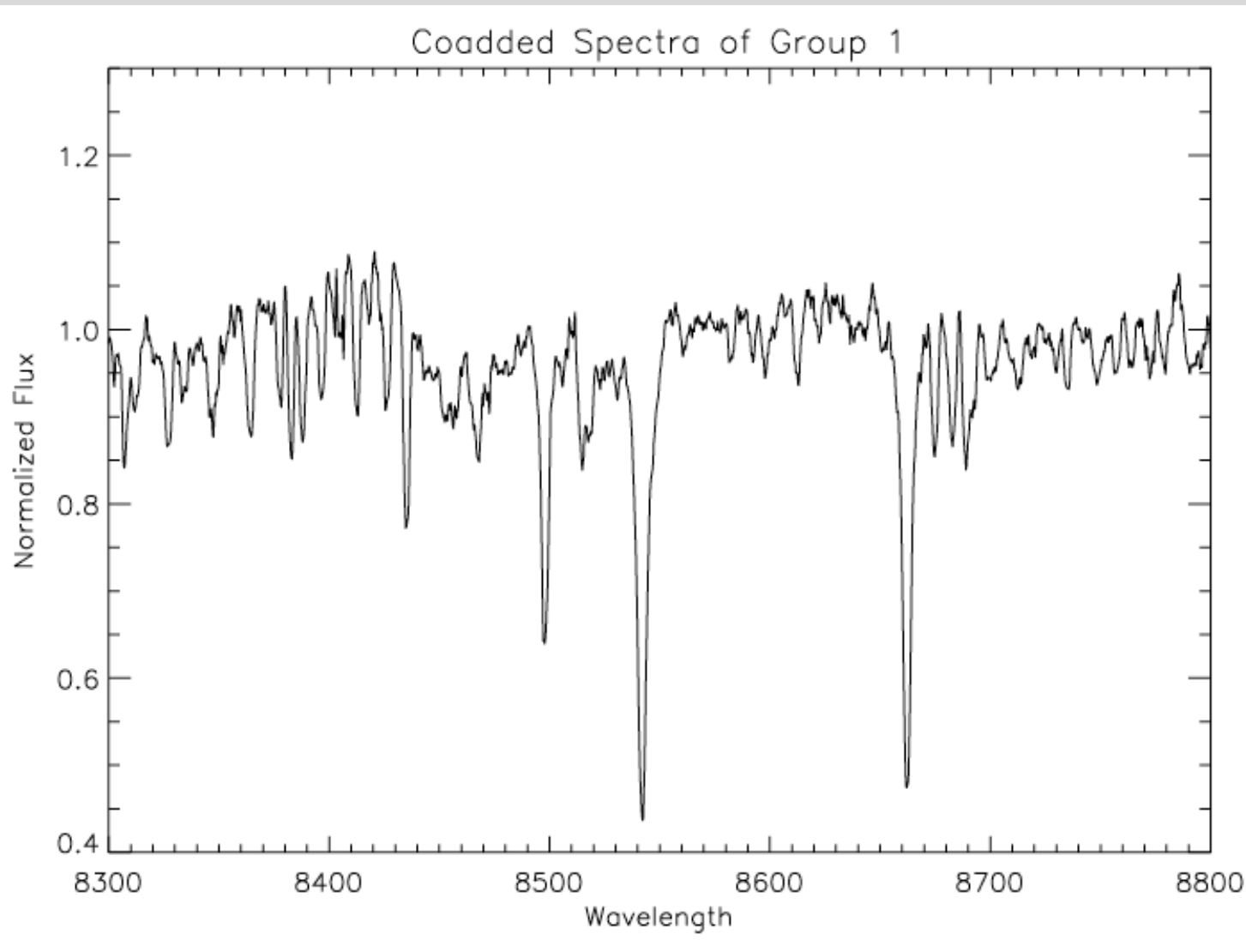


Elisa Toloba, Eric Peng, Jingjing Chen, Biao Li
Stephanie Chen, Samyu Yagati, Anneliese Gallagher, Mary Liu
Pat Côté, Laura Ferrarese, Andres Jordan

Characterizing dwarf satellites in the Local Group

- Chemical abundance measurements of old stars are very challenging with Keck
- Metallicity distribution functions of dwarf satellites from spectra of *individual* stars versus mean metallicities of dwarf satellites from *co-added* spectra

Series of *co-added* spectra of red giant stars in the luminous Andromeda satellite, NGC 147



Lucy Cheng
Harker High School
(summer intern at
UCSC)

Lei Yang
KIAA/Peking Univ
(visiting student at
UCSC + Caltech)

Detailed chemical
abundances from
co-added spectra of
RGB stars in M31
dSph/dE galaxies
(paper in prep)

Weak “metal” absorption lines are clearly detectable in co-added spectra

Evan Kirby, PhD
thesis, UCSC

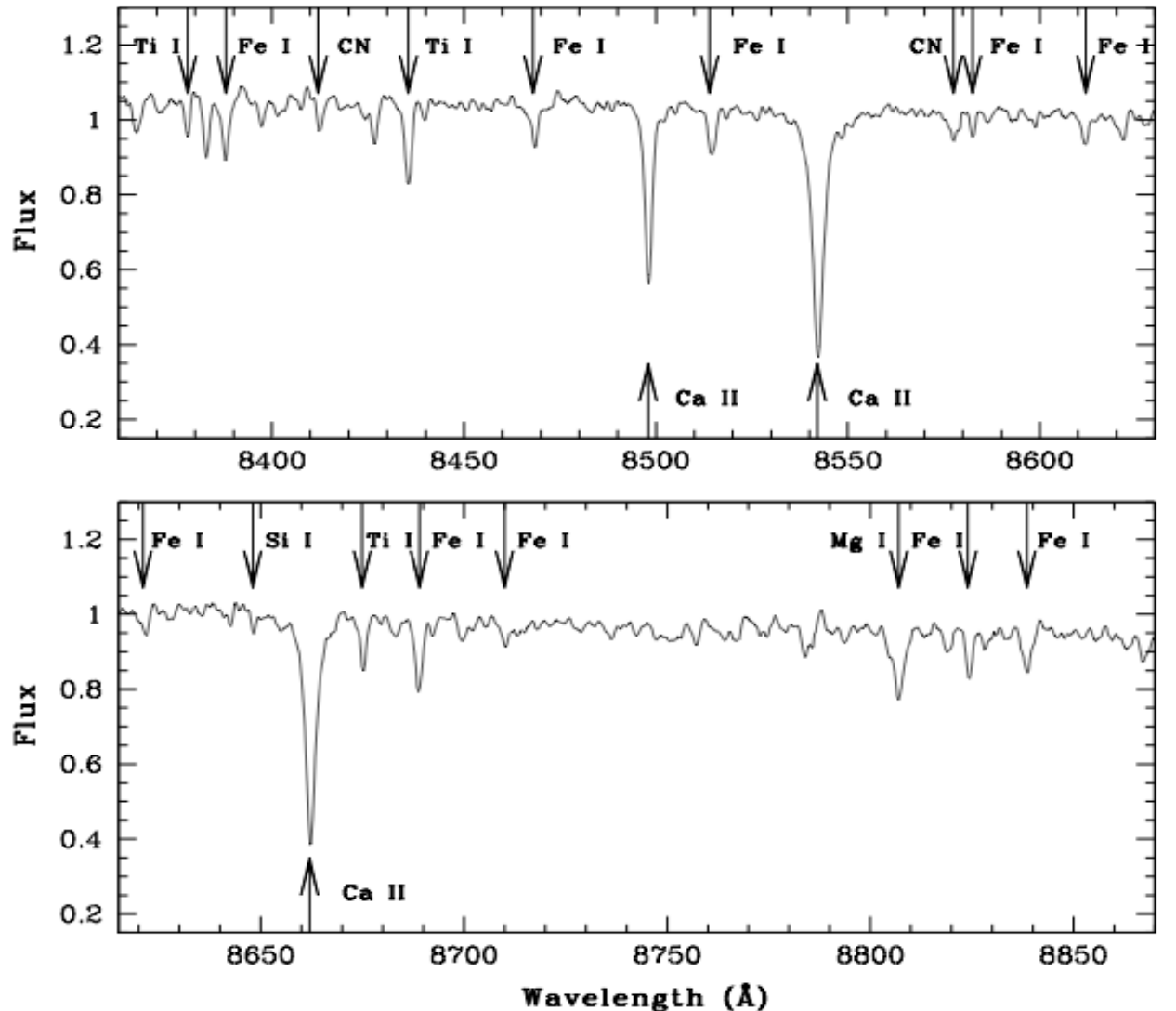
Detailed chemical
abundances from
Keck/DEIMOS
spectra of individual
red giant stars in
MW GCs and dSph
satellite galaxies:

– Kirby, PG &
Snedden (2008, ApJ)

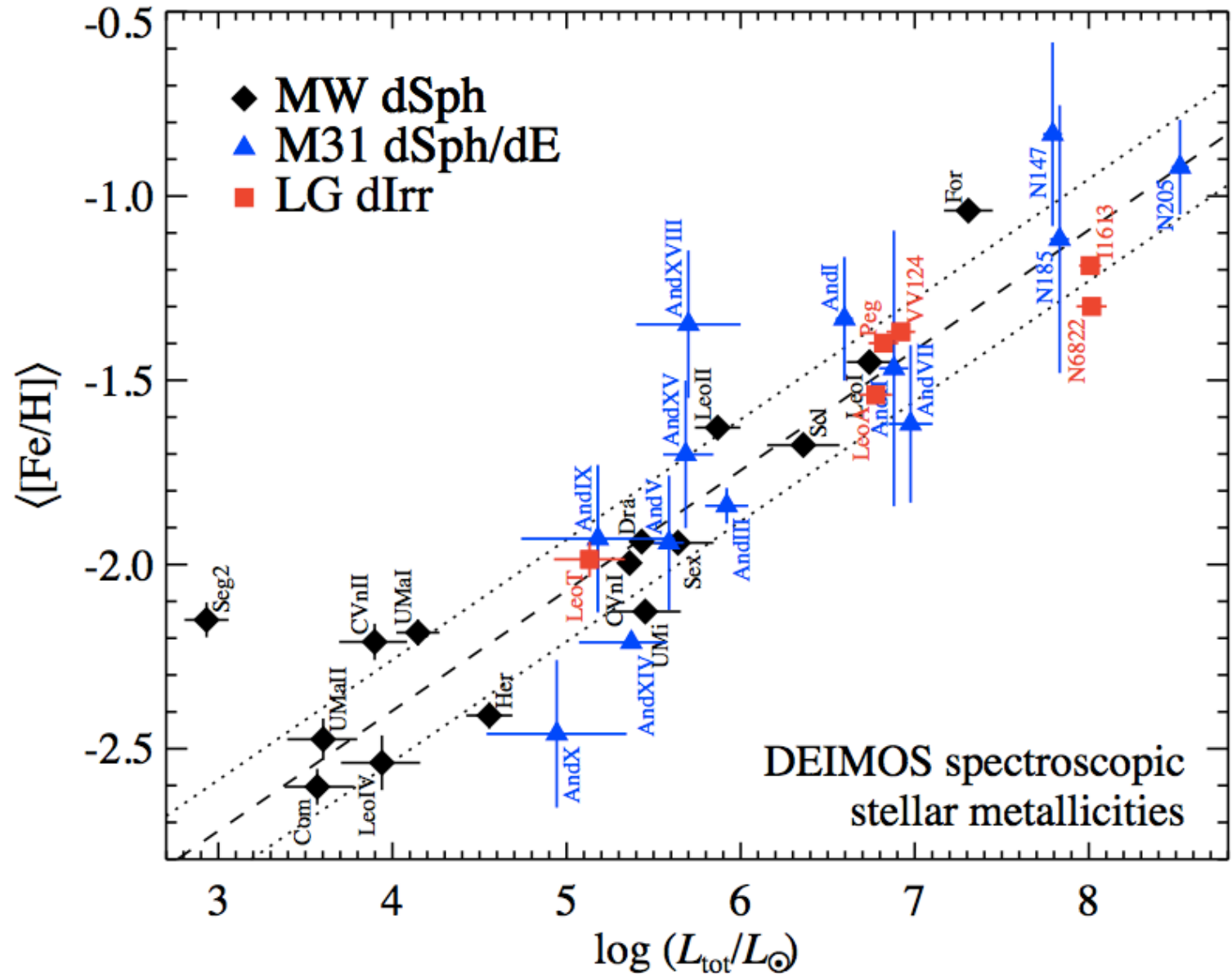
– Kirby et al.
(2009–2011)

Lei Yang, MS thesis,
KIAA/PKU (+ UCSC
+ Caltech)

Detailed chemical
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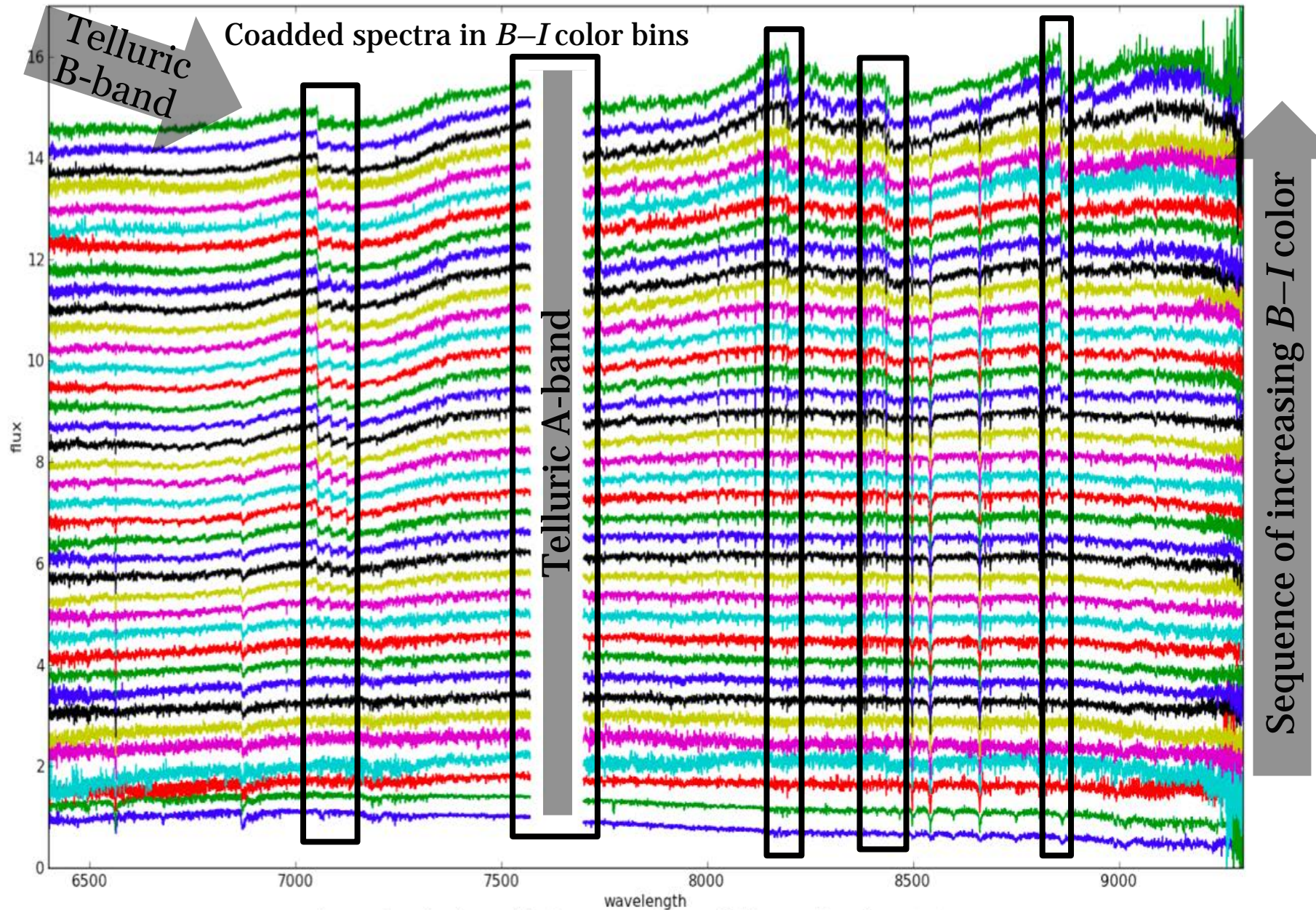
Andromeda satellites resemble their Milky Way counterparts



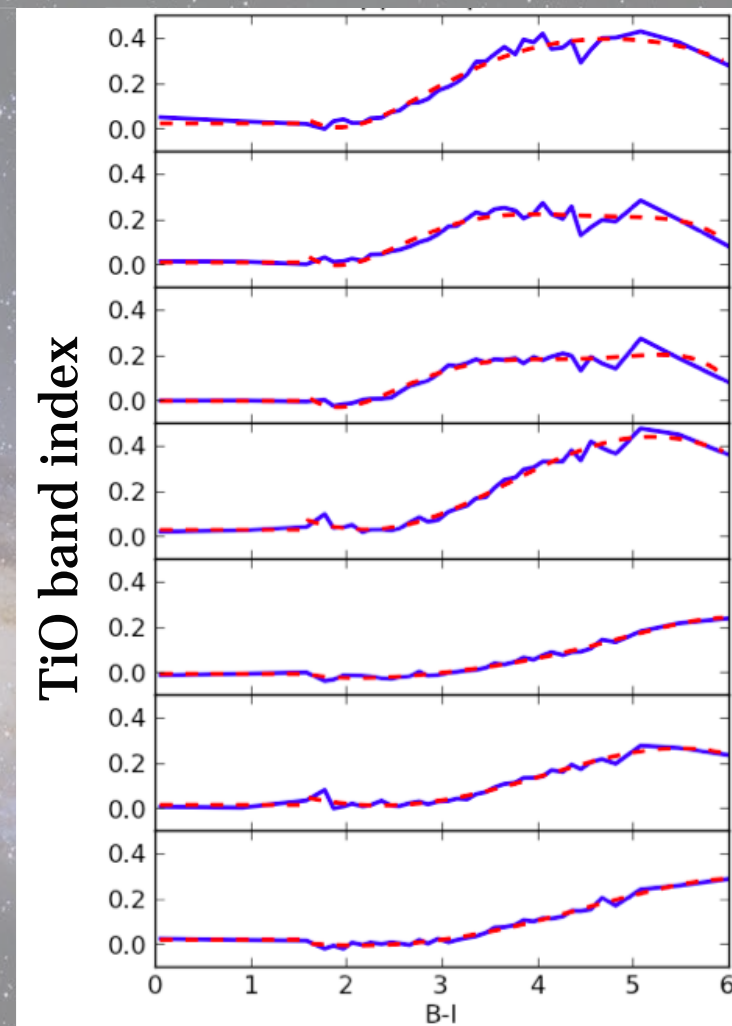
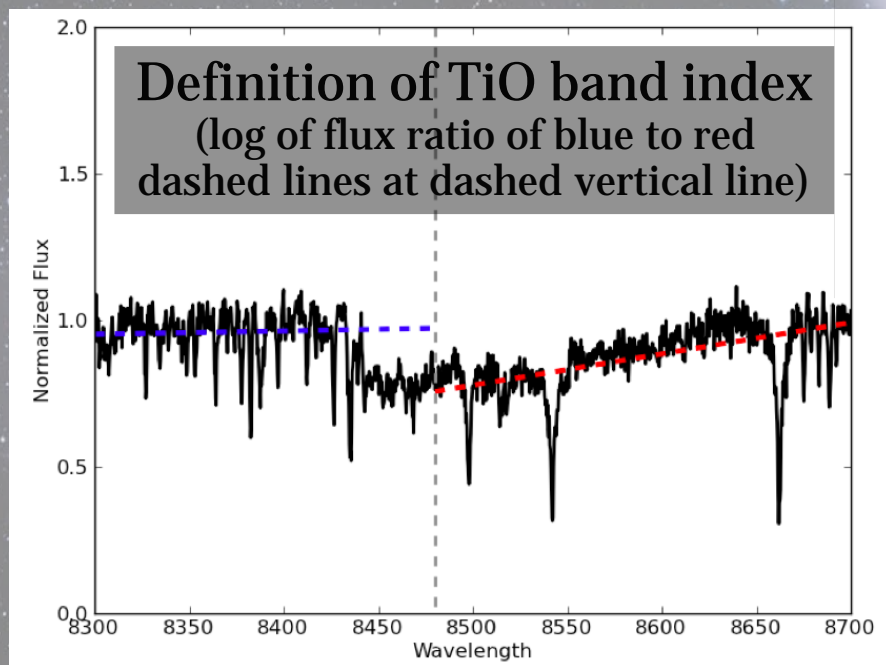
Dust mapping in the disk of the Andromeda galaxy

- M31: A laboratory for interstellar medium studies
- Combining the power of HST and Keck: Need to work with *co-added* spectra now but can target *individual* stars with TMT

“Thermometry” of M giant stars



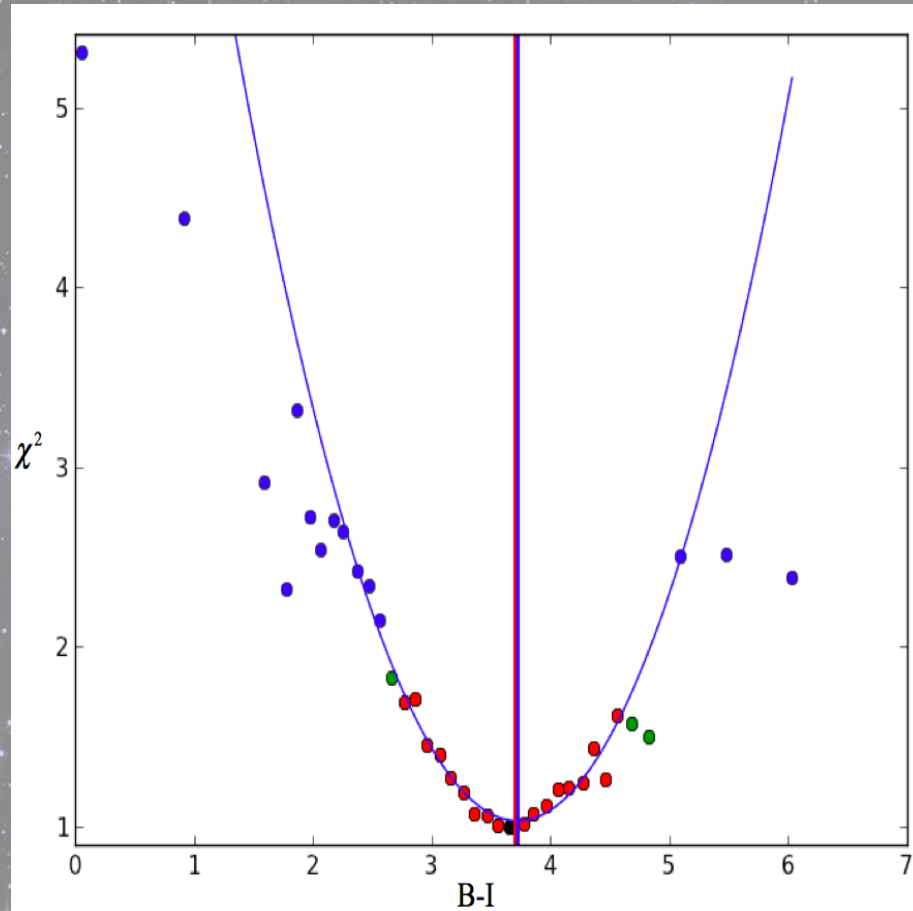
“Thermometry” of M giant stars



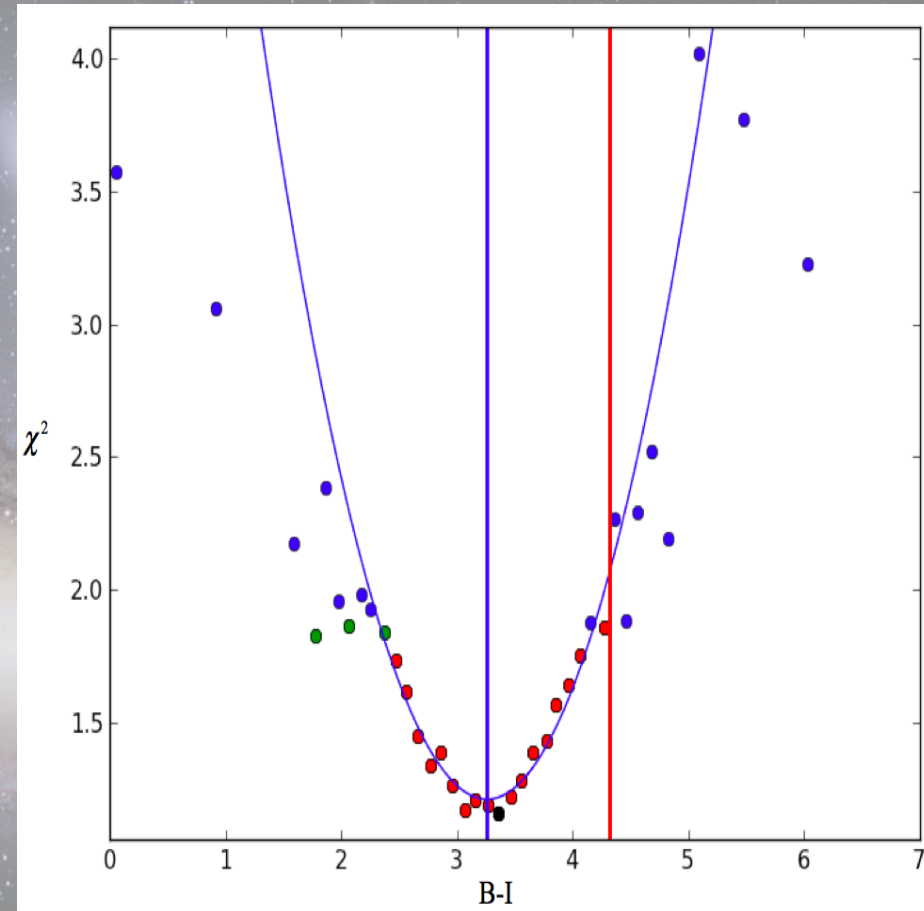
Teresa Krause (*Castilleja School*)

Katie Hamren, Claire Dorman, Elisa Toloba (*UCSC*)
Sumedh Guha (*Archbishop Mitty High School*)

Application of M giant thermometer: Dust reddening



Unreddened star



Reddened star

Teresa Krause (*Castilleja School*)
Katie Hamren, Patrick Draper (*UCSC*)

Substructure in and mass of the Milky Way

- Leveraging the remarkable *astrometric* potential of deep, multi-epoch HST images
- Need TMT to measure radial velocities of faint blue main sequence turnoff stars in the MW outer halo

Sideways Stellar Motions Suggest Shell in Milky Way Halo



6D mapping of the Milky Way halo: Accretion history and mass estimate

- ❖ Approved Cycle 21 archival HST program to analyze all deep, multi-epoch fields with a total time baseline of ~ 5 years or more
- ❖ We expect to measure proper motions for ~ 700 MW halo stars across ~ 150 lines of sight with a precision of $5\text{--}20$ km/s at $D \sim 25\text{--}100$ kpc
- ❖ Need TMT/MOBIE to measure radial velocities (and chemical abundances?) of faint MSTO stars

HSTPROMO: The HST Proper Motion Collaboration
Roeland van der Marel, Jay Anderson, Tony Sohn (STScI)
Alis Deason, Emily Cunningham (UCSC)

Summary: Examples of what TMT can do for Local Group / Local Volume science

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