Stellar Dereddening for APOGEE

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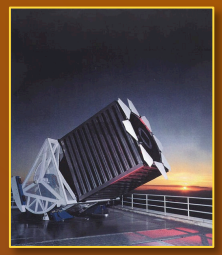
David Nidever (UVa),
&
the APOGEE team

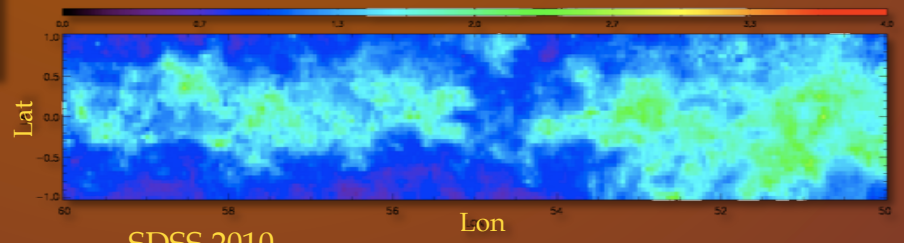
Outline

- The dusty Milky Way disk

- Interstellar dust extinction – a challenge and an opportunity
- Dereddening with the Rayleigh-Jeans Color Excess (RJCE) Method
- APOGEE targeting



- Extinction science



The Milky Way's Dusty Disk

The Milky Way is a crucial galactic laboratory.

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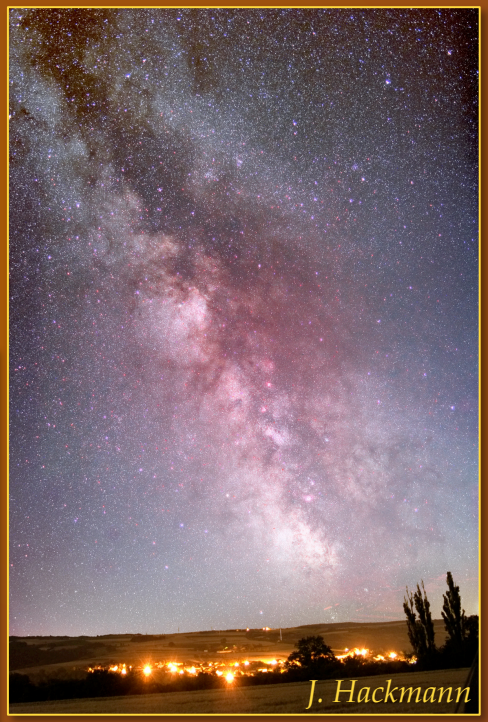
The Milky Way is a crucial galactic laboratory.

Galactic disks are full of thick, patchy dust clouds.


NGC 4594, *Hubblesite.org*


J. Hackmann

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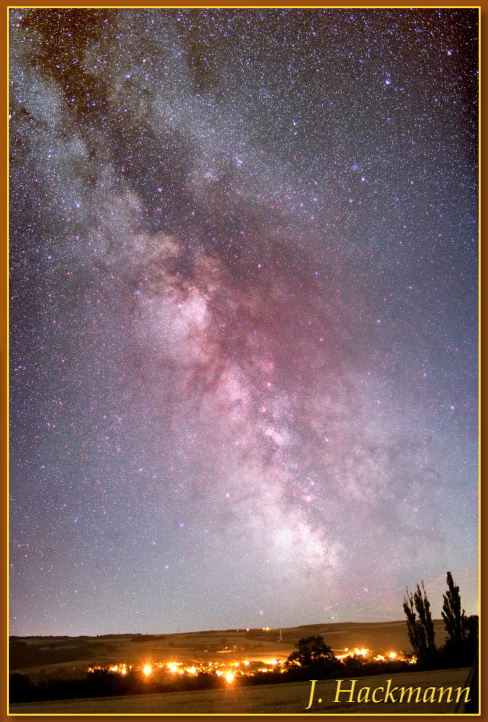


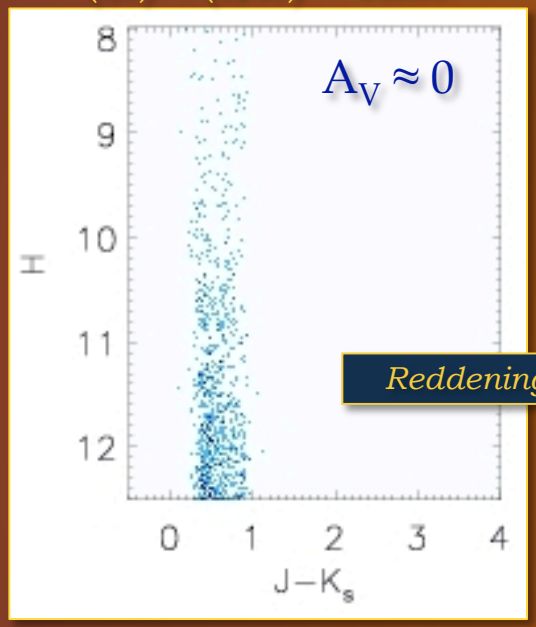
J. Hackmann

Extinction effects are reduced at longer wavelengths.

MW center: optical (top) and IR (bottom, *2MASS*)

The Milky Way's Dusty Disk

$(l,b) = (0,45)°$ - Halo

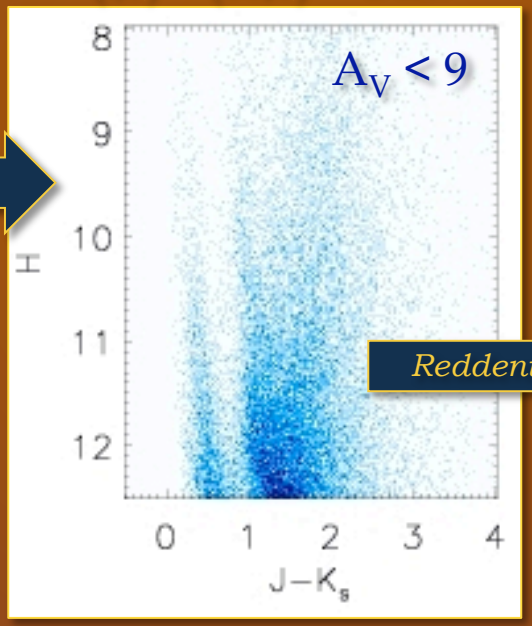


2MASS

Reddening

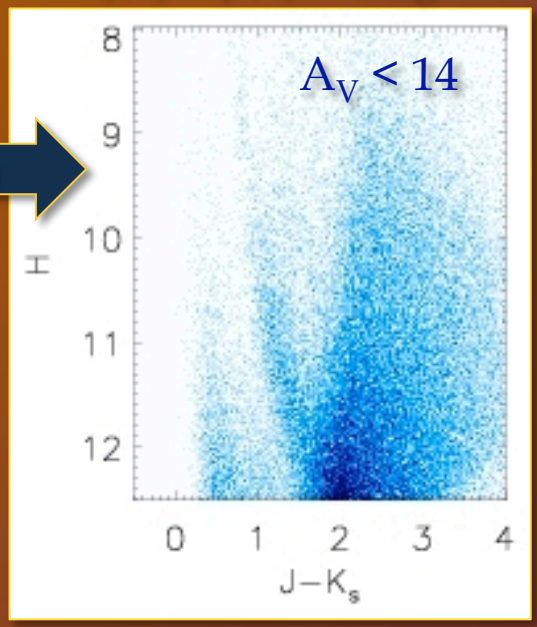
Even in the IR, reddened stellar populations are difficult to identify and trace.

$(l,b) = (60,0)°$ - Disk



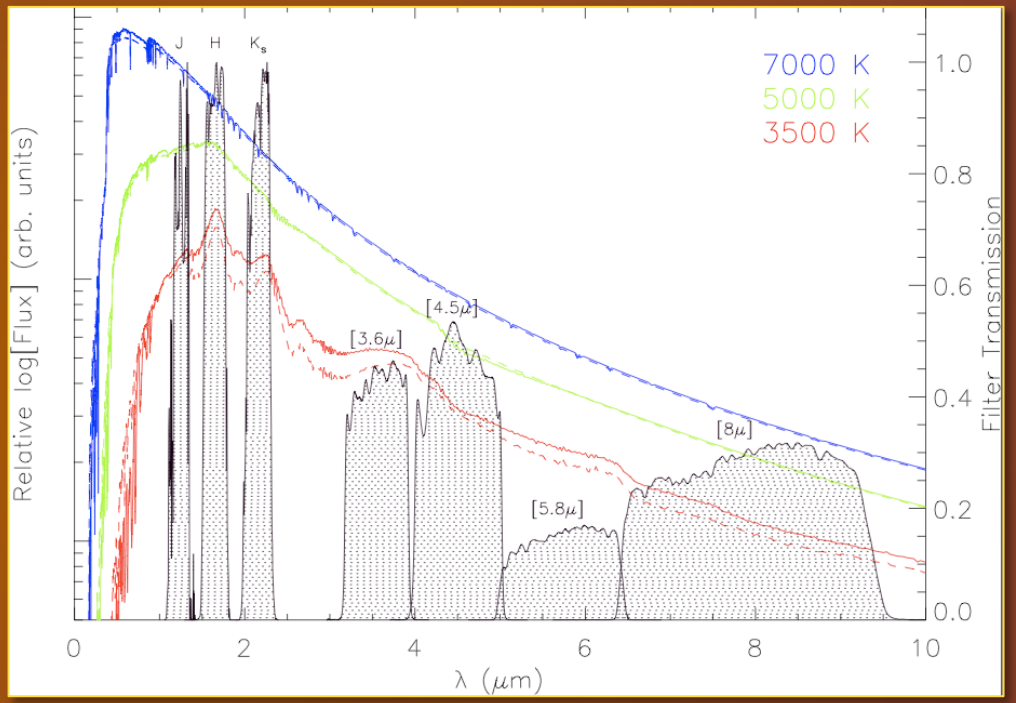
Reddening

$(l,b) = (3,0)°$ - Bulge



RJCE – Rayleigh-Jeans Color Excess

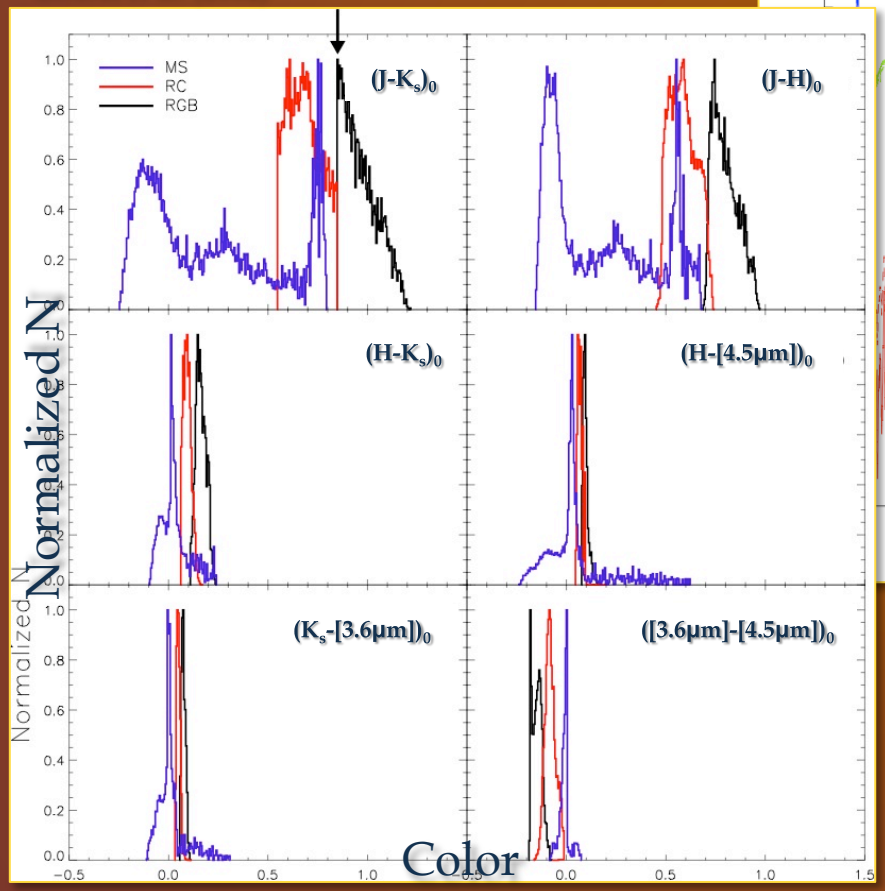
Almost all normal stars share a common SED *shape* at NIR/MIR wavelengths.

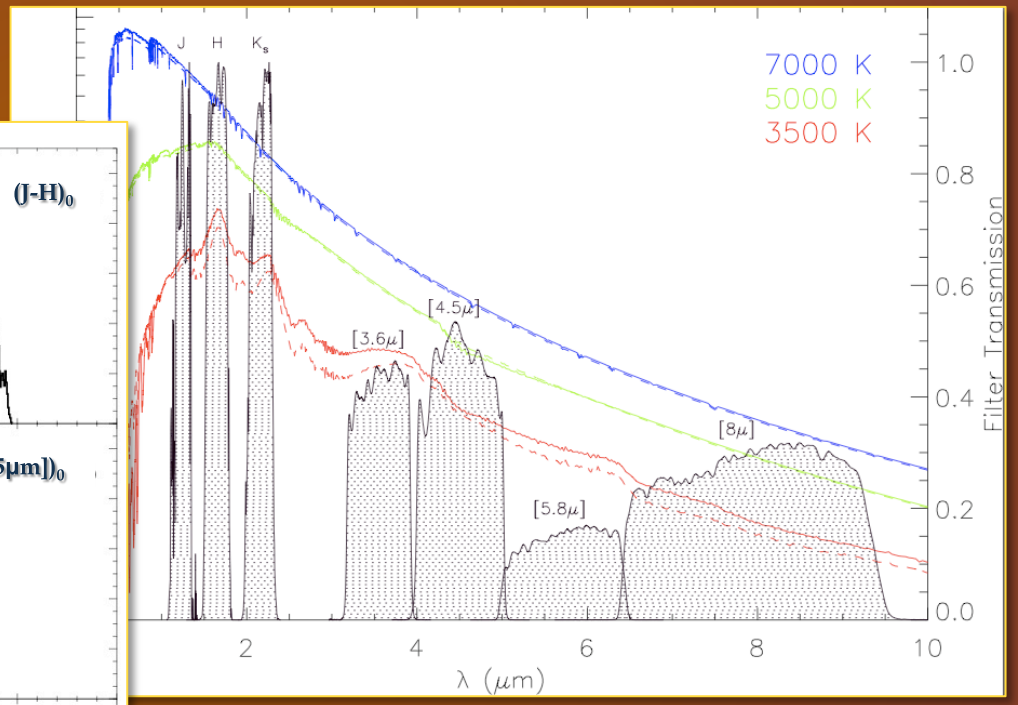


Castelli & Kurucz (2004) stellar models

RJCE – Rayleigh-Jeans Color Excess

Girardi et al. (2002)





Castelli & Kurucz (2004) stellar models

NIR+MIR colors are very uniform, regardless of stellar type!

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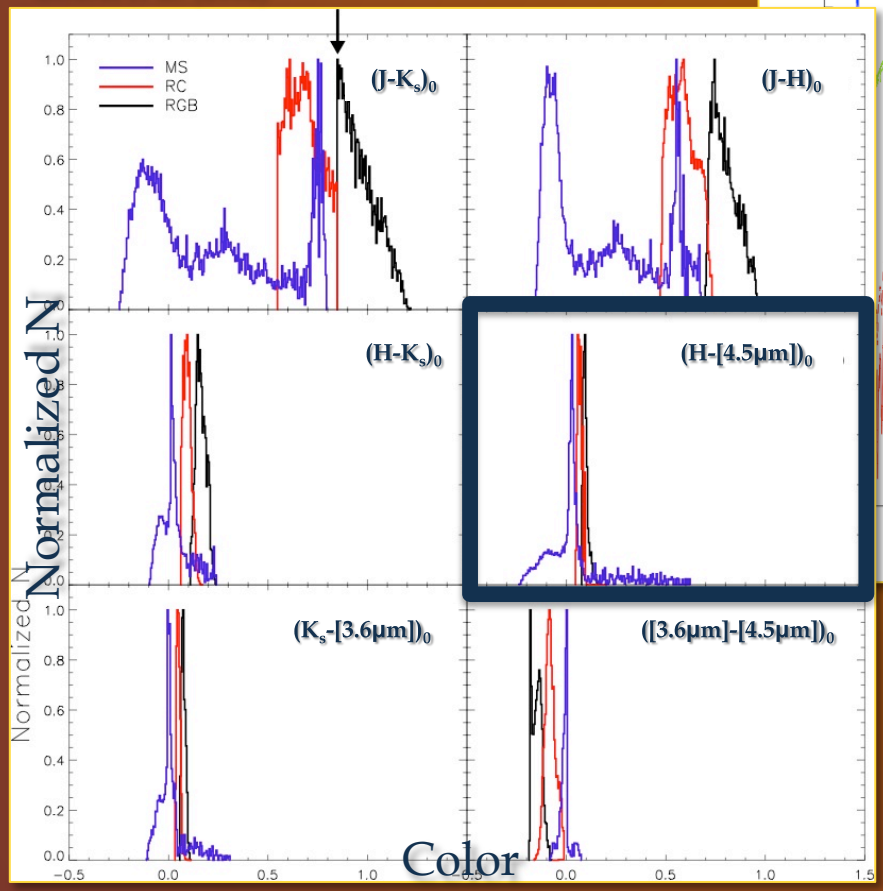

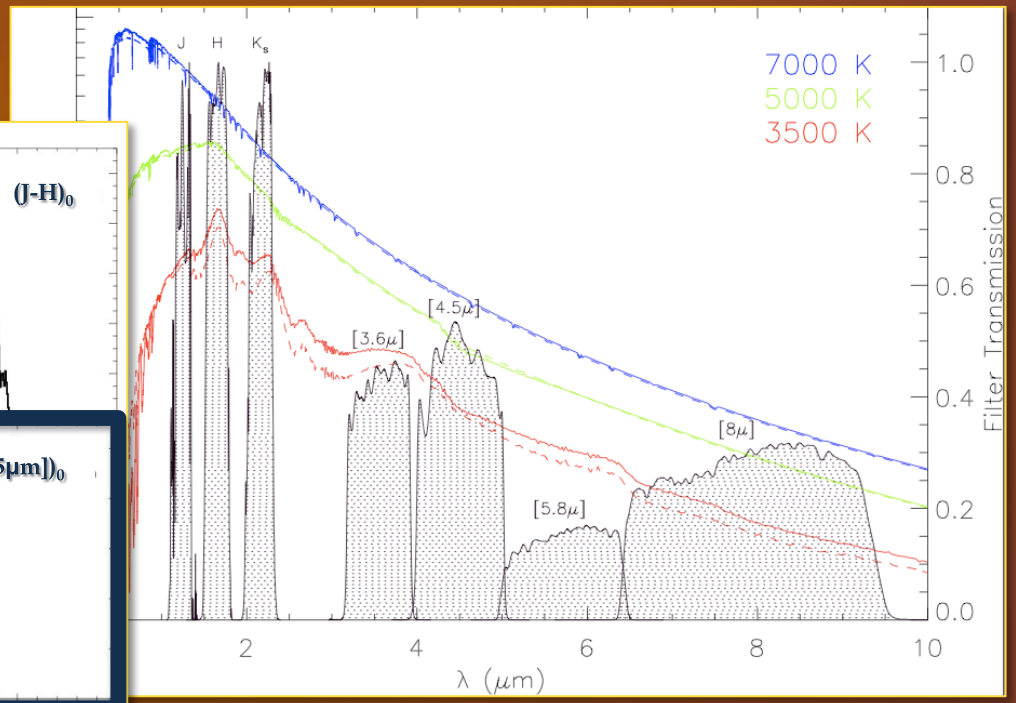

Castelli & Kurucz (2004) stellar models

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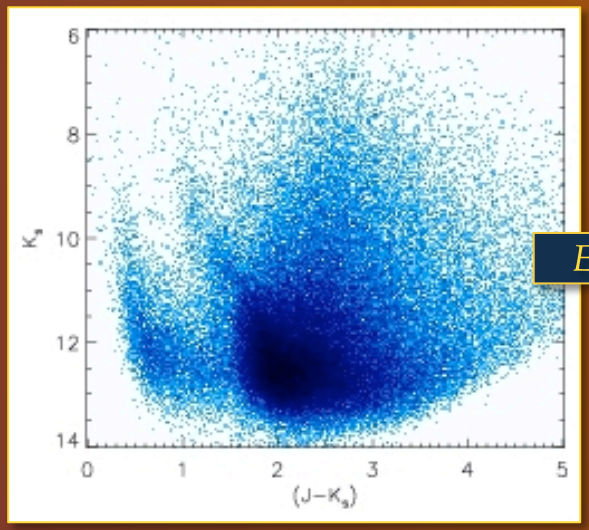
RJCE – Rayleigh-Jeans Color Excess

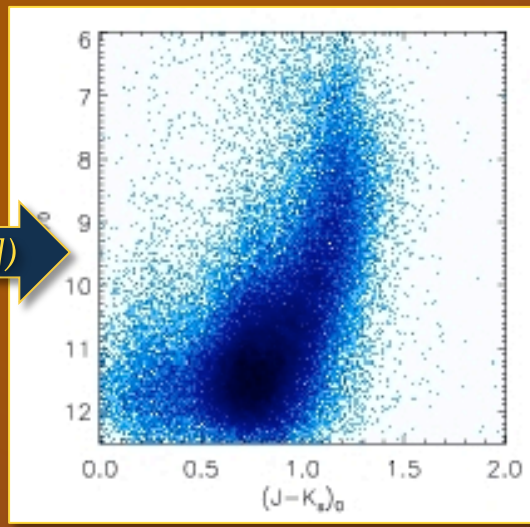
NIR+MIR color *excesses* indicate amount of reddening…

Observed 2MASS, (42,0)°

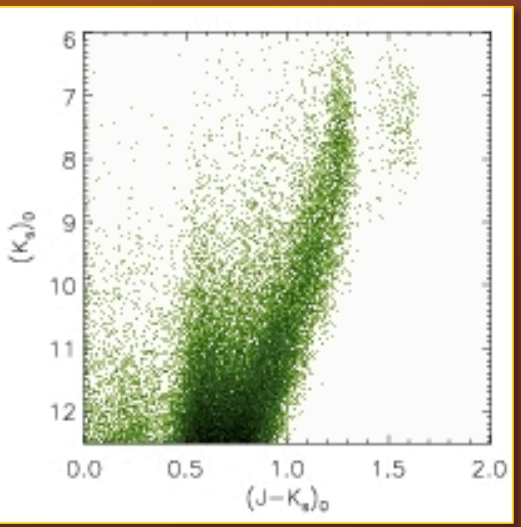


E(H-[4.5μm])

Corrected 2MASS



TRILEGAL model

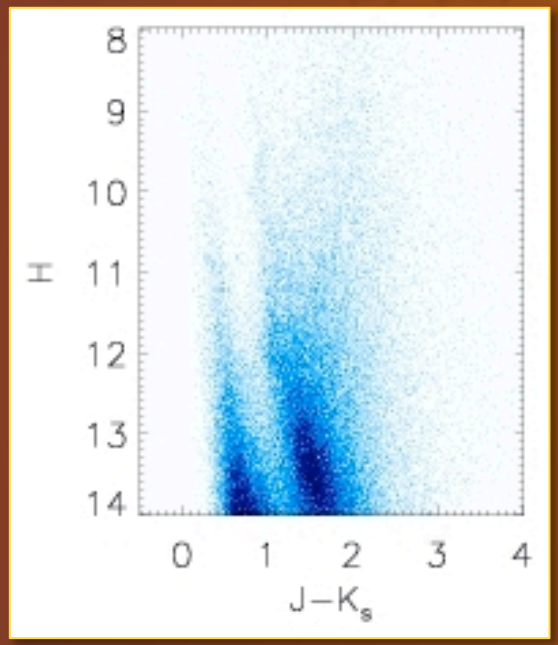


Girardi et al. (2005)

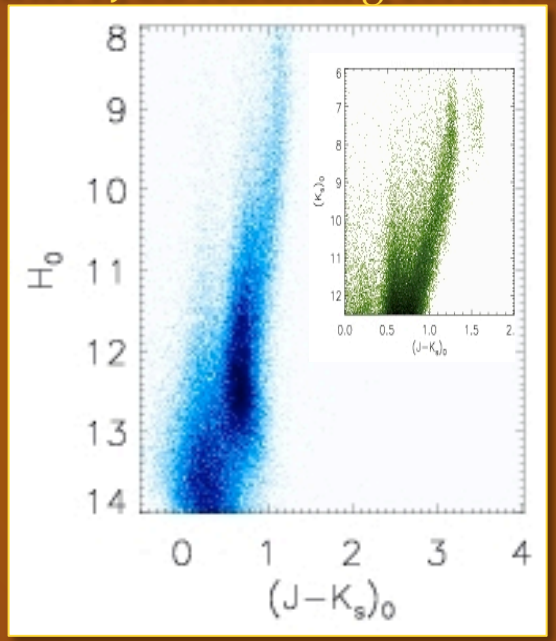
…and corrected NIR colors indicate stellar type!

Dereddening in APOGEE

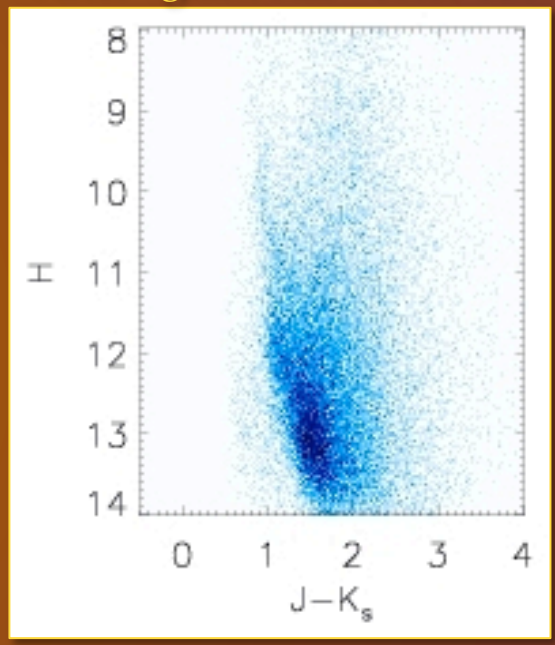
Uncorrected 2MASS, $(l,b) = (60,0)°$



After RJCE reddening correction



After "giant star" color cut



Selection using corrected colors allows rejection of foreground dwarf stars.

Lack of further color cuts helps to avoid age or metallicity biases.

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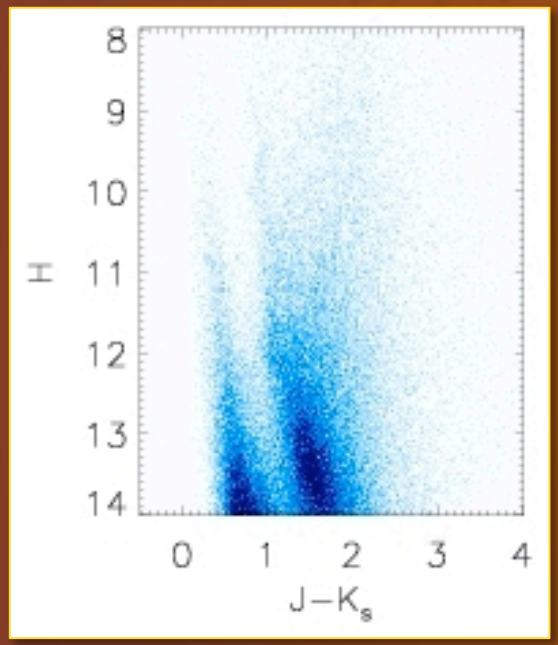

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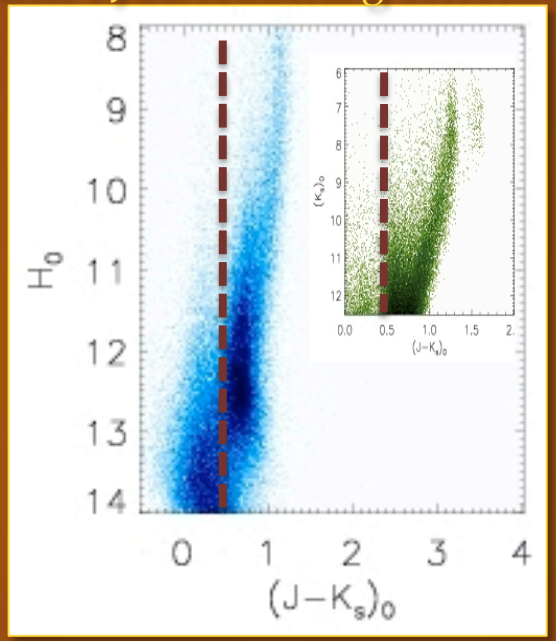

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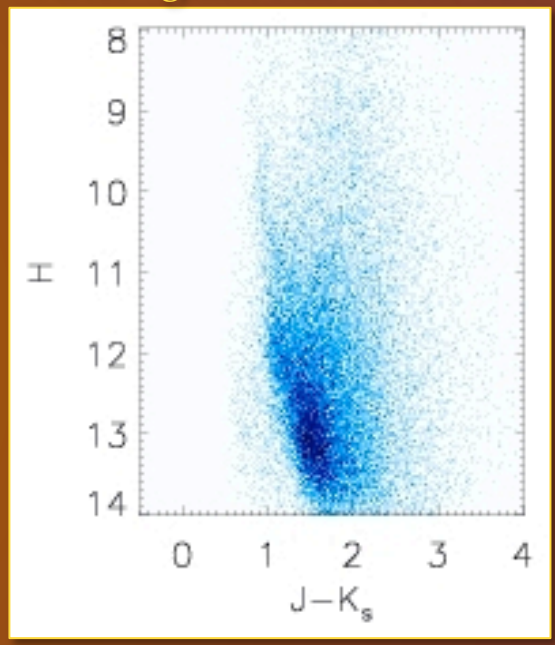

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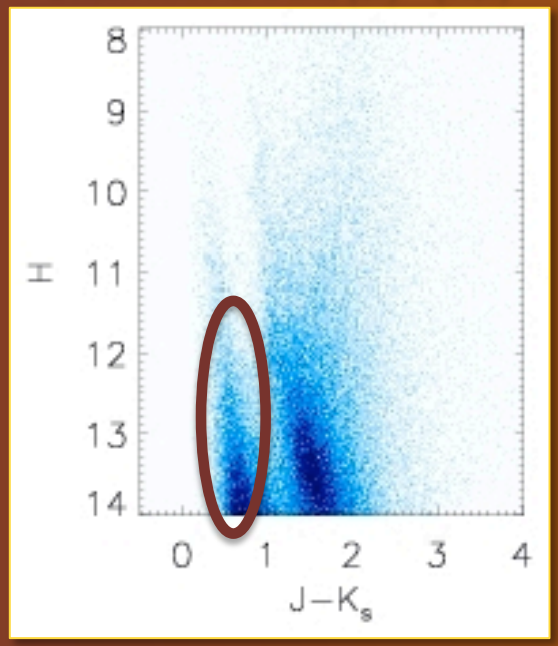

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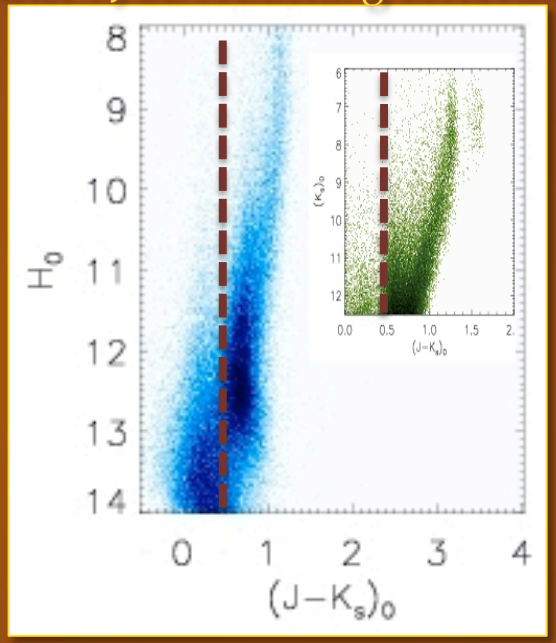

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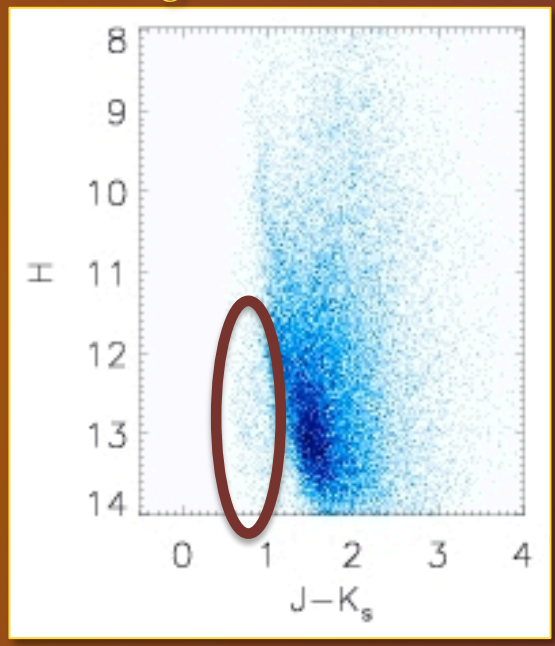

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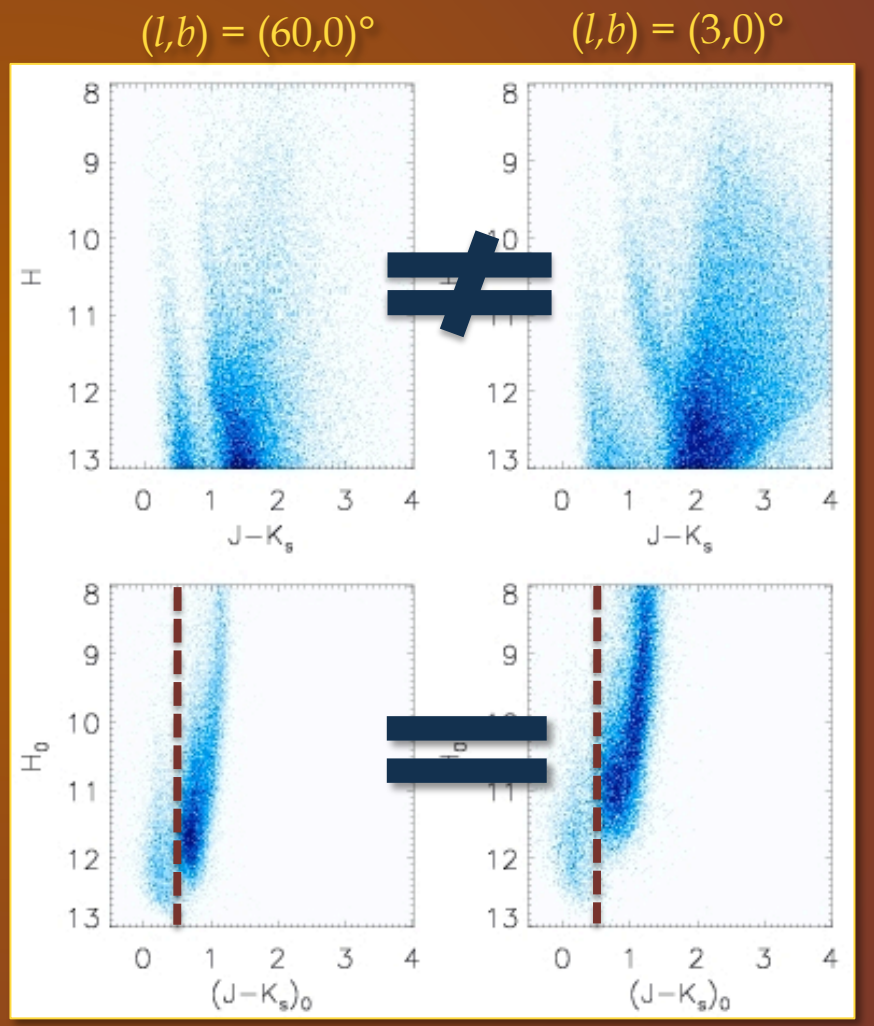
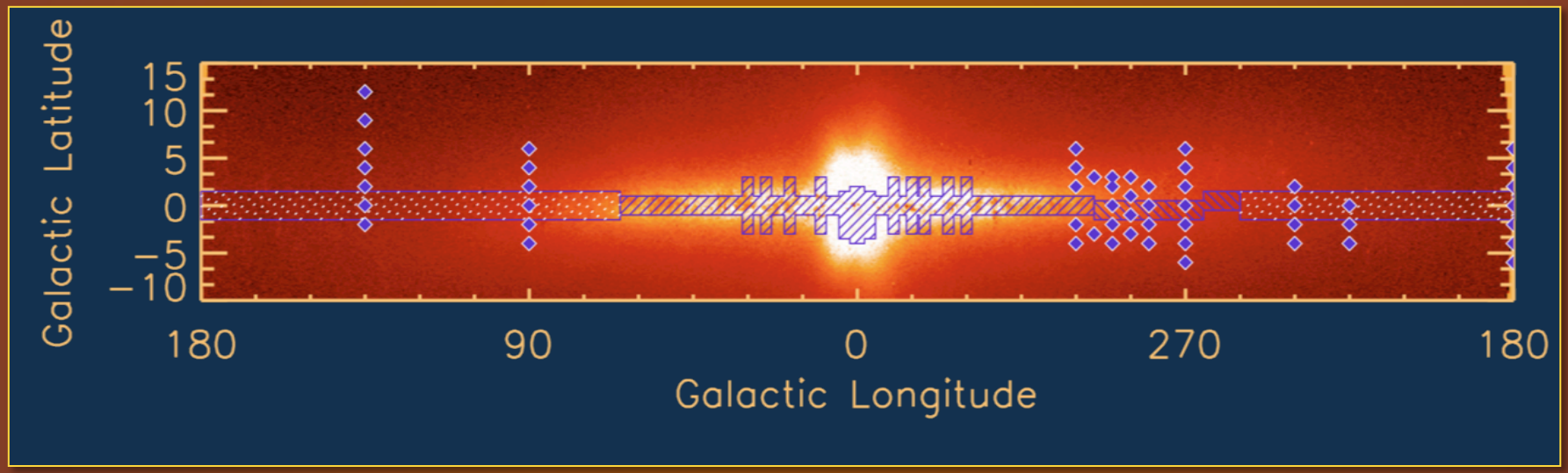
Dereddening in APOGEE

RJCE brings *uniformity* to APOGEE targeting.



Dereddening in APOGEE

In midplane and bulge, where $A(H)$ is highest, *Spitzer*-IRAC MIR data is available.



Elsewhere, we will take advantage of the new all-sky WISE photometry.

Dereddening Science

Comparison between ***RJCE-derived photometric temperatures*** and ***APOGEE-derived spectroscopic temperatures*** will test the stellar models used and refine the RJCE method.

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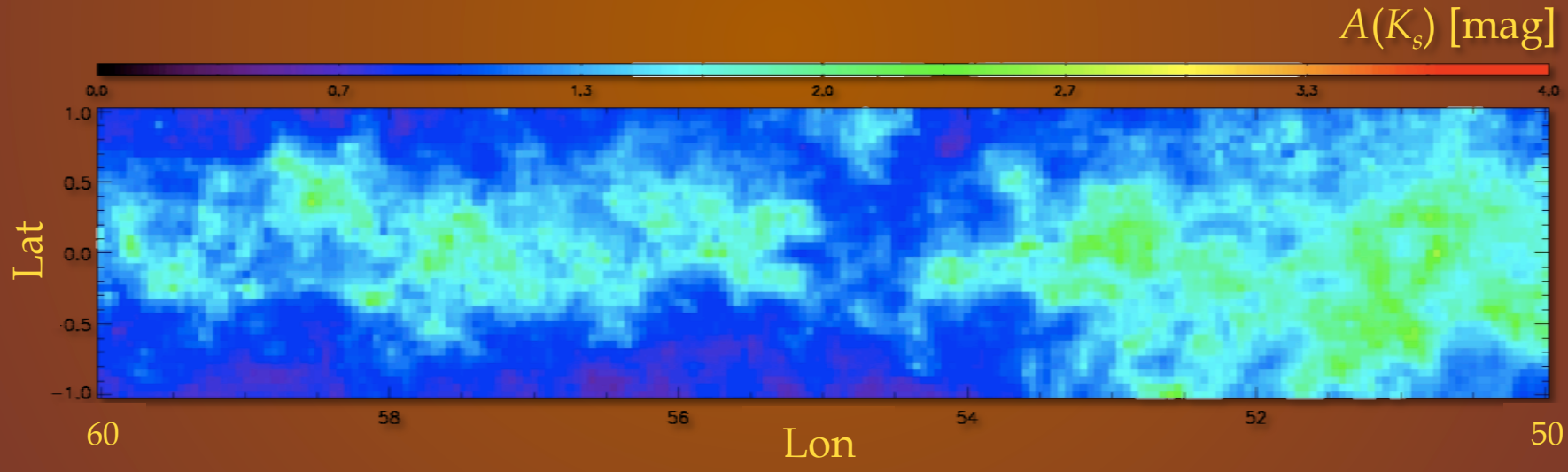
RJCE enables high-resolution extinction maps:



Majewski, Zasowski, & Nidever (sub.)

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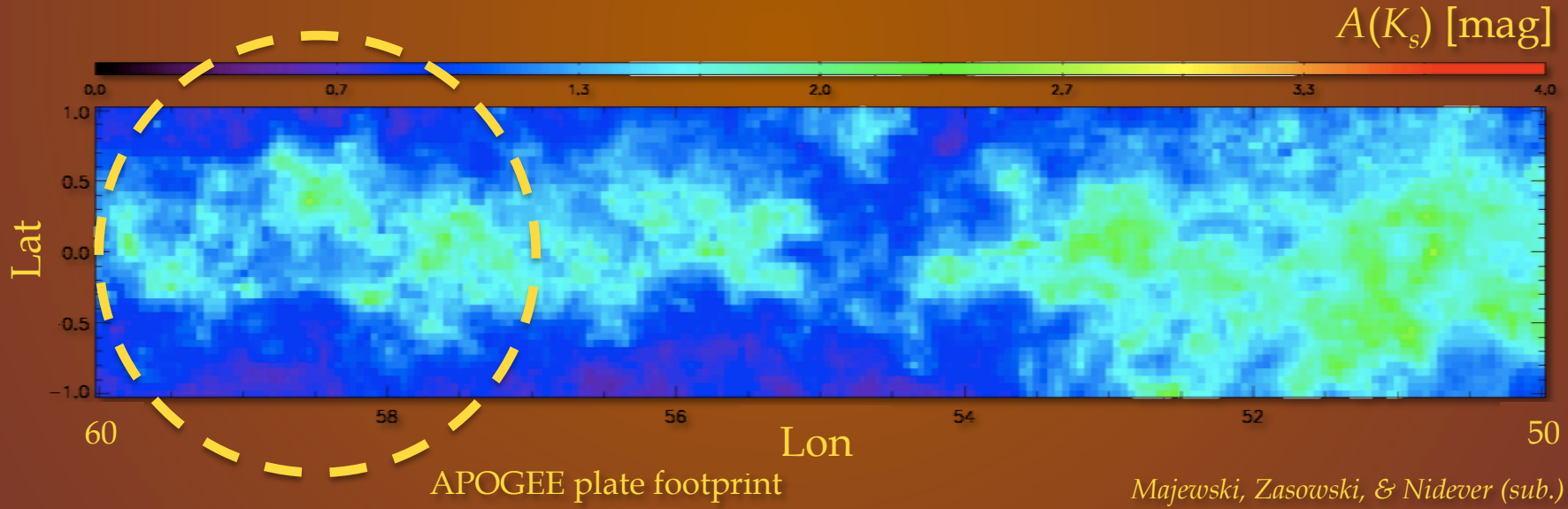
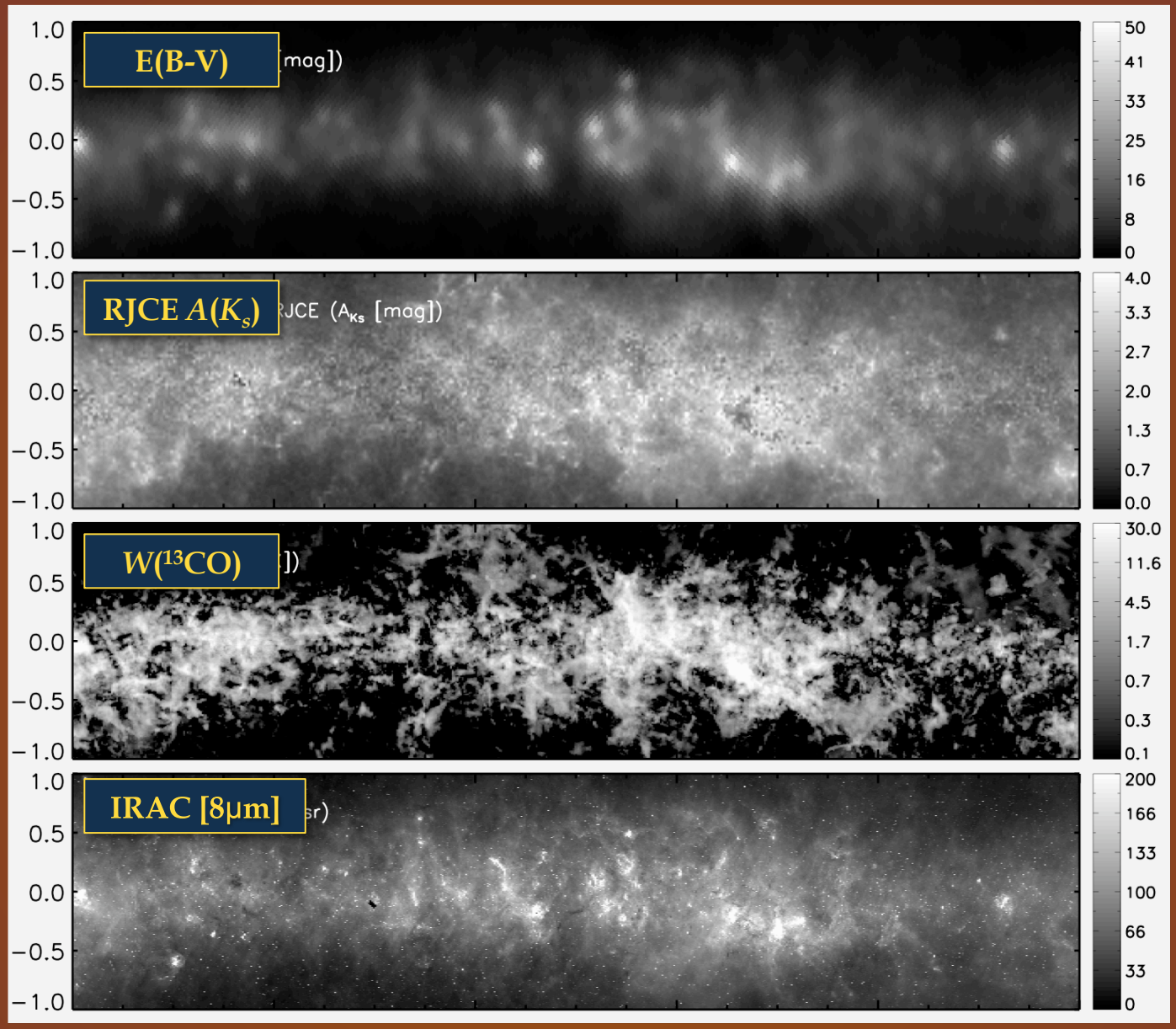


APOGEE plate footprint

Majewski, Zasowski, & Nidever (sub.)



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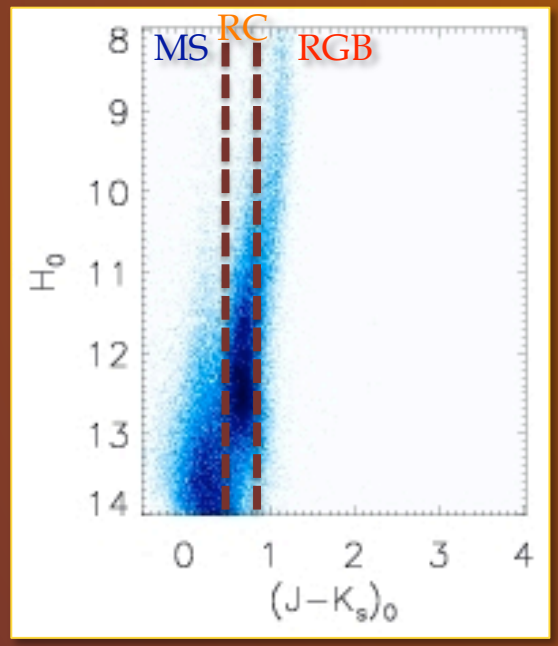

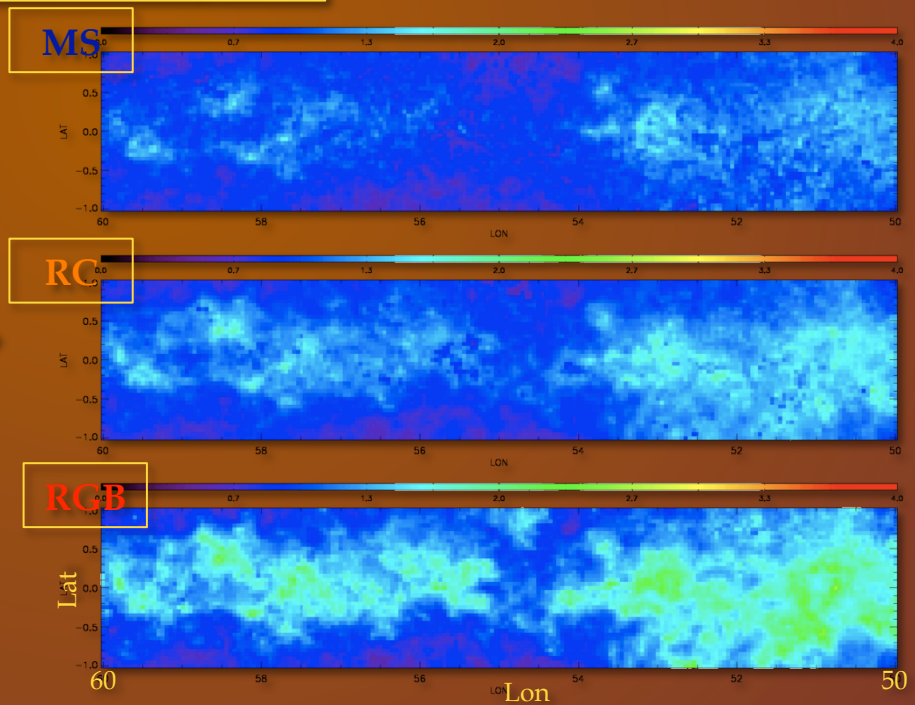

Nidever, Zasowski, & Majewski (sub.)

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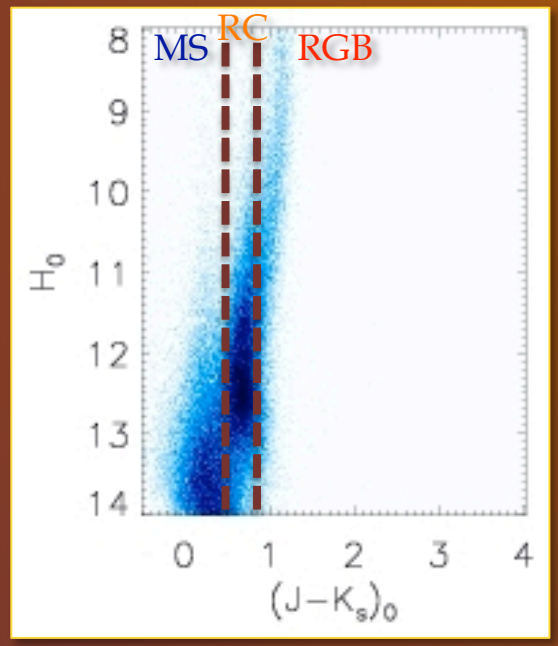
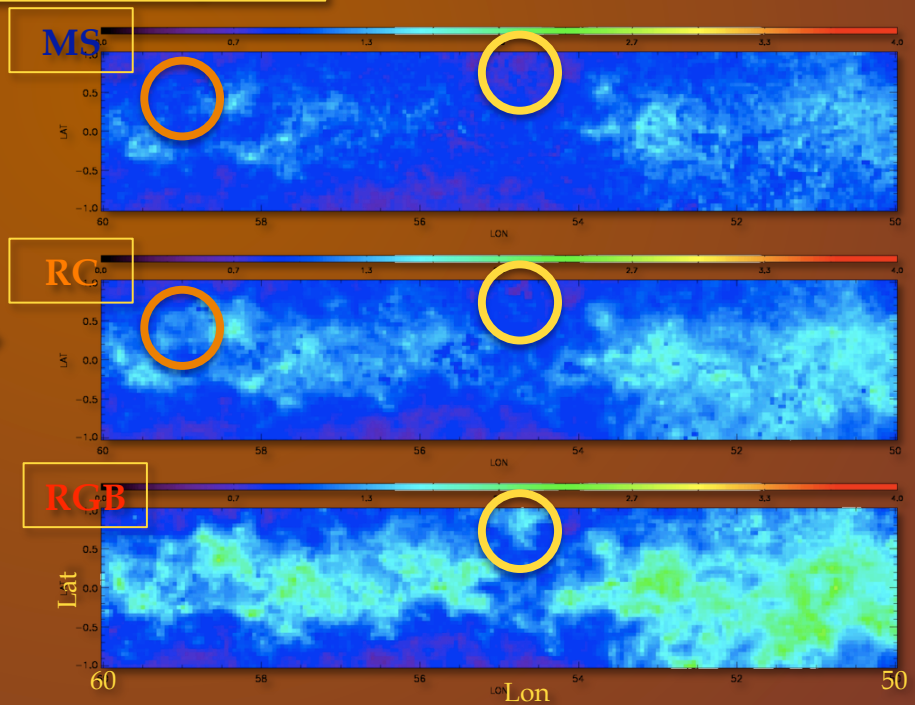
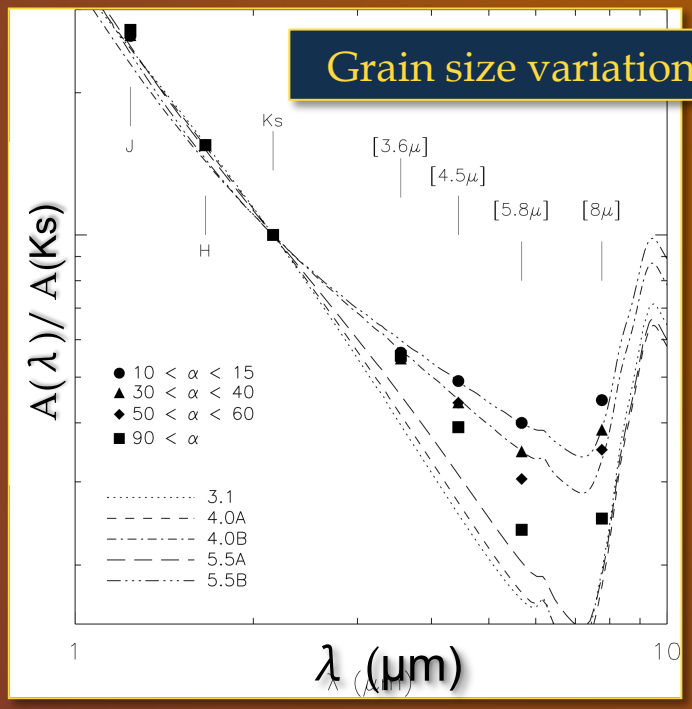




Dereddening Science

There is evidence for variation in the IR extinction law as a function of Galactic radius.



Zasowski et al. (2009)

Dereddening Science

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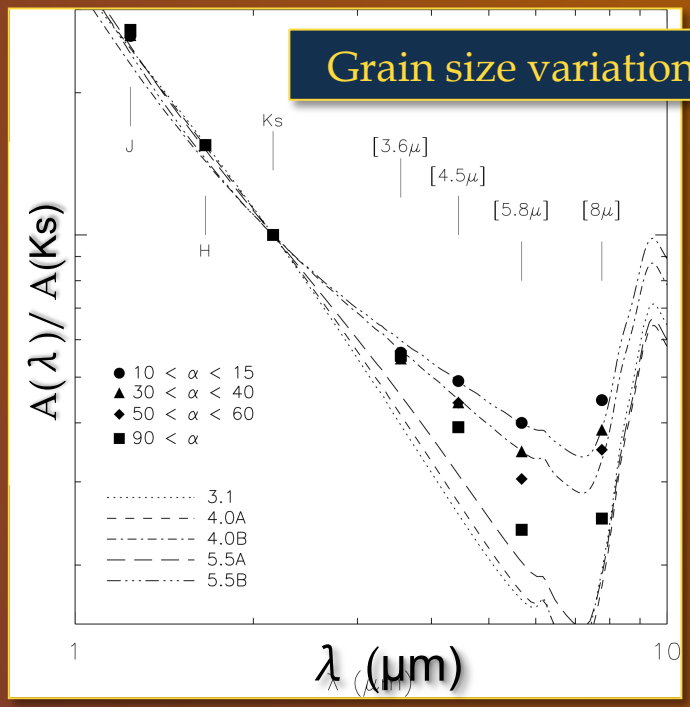
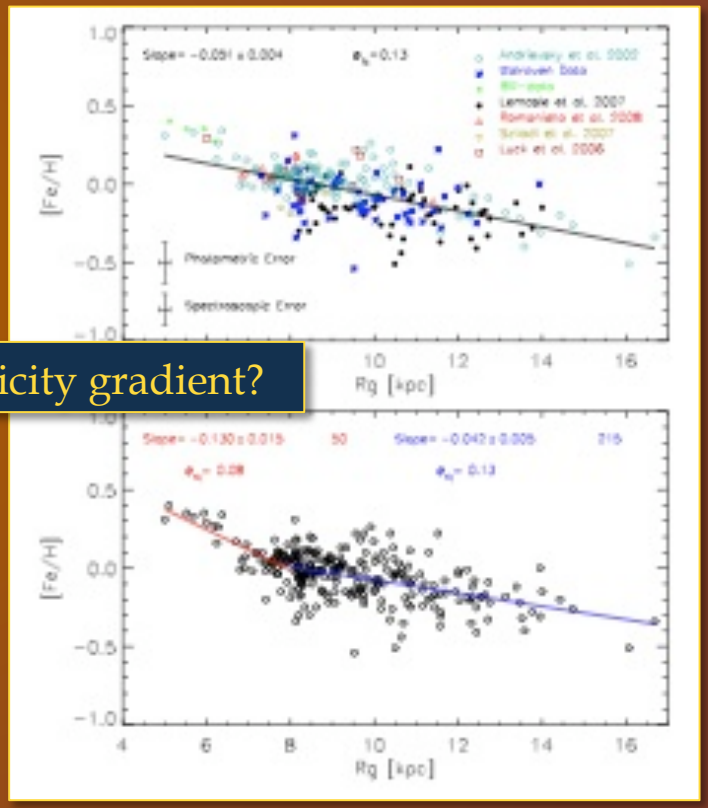
Grain size variations?



Zasowski et al. (2009)

Metallicity gradient?



Pedicelli et al. (2009)

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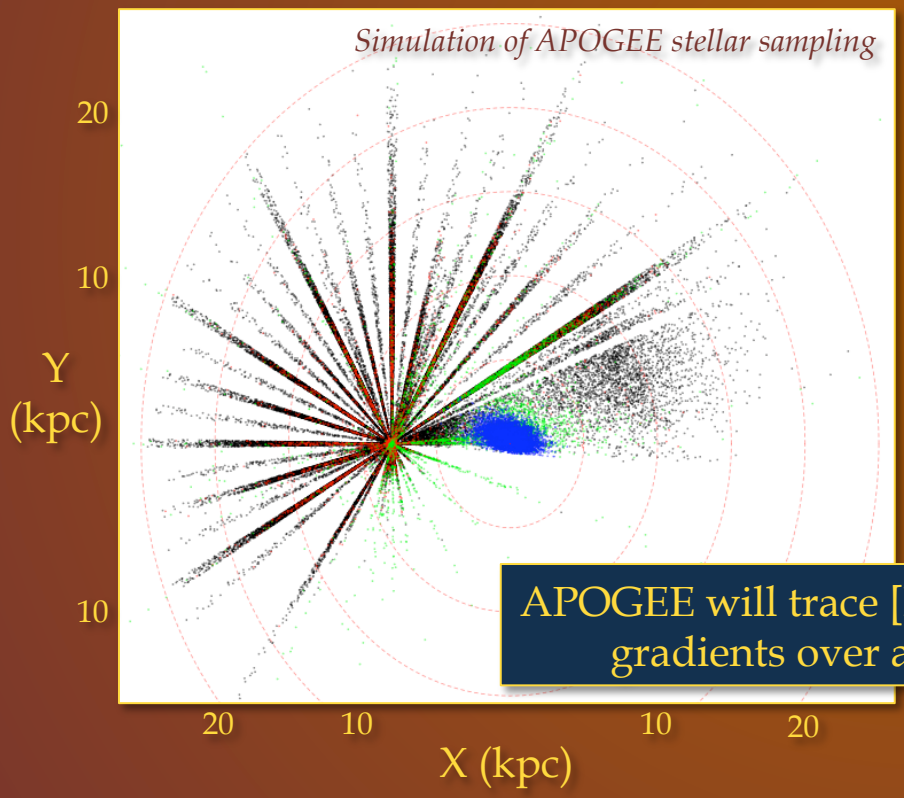

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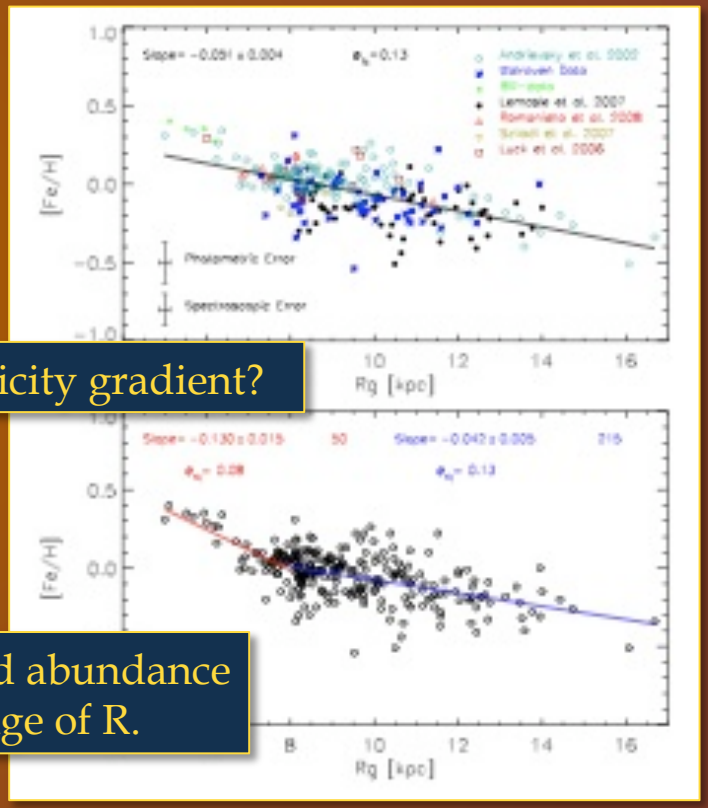


APOGEE will trace [Fe/H] and abundance gradients over a large range of R.

Pedicelli et al. (2009)

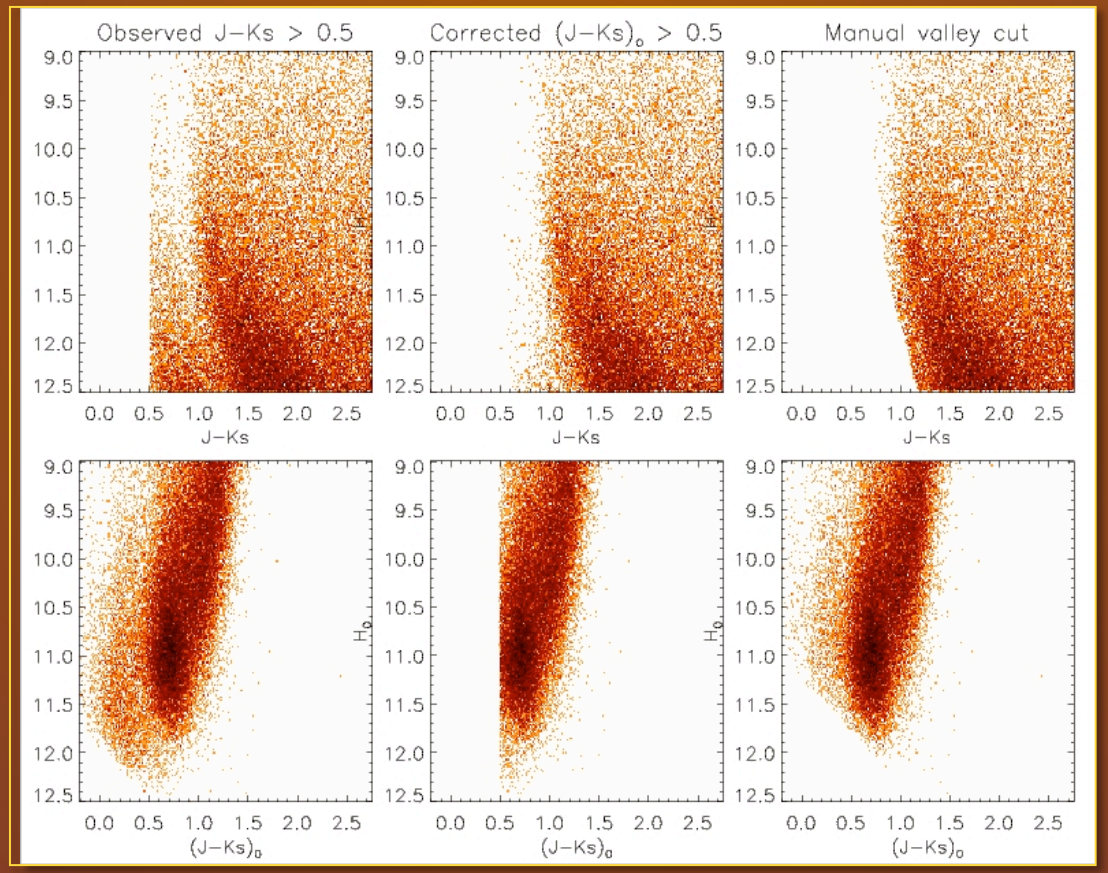
Thank you

Additional Slides

Target Selection

Science Target Dereddening

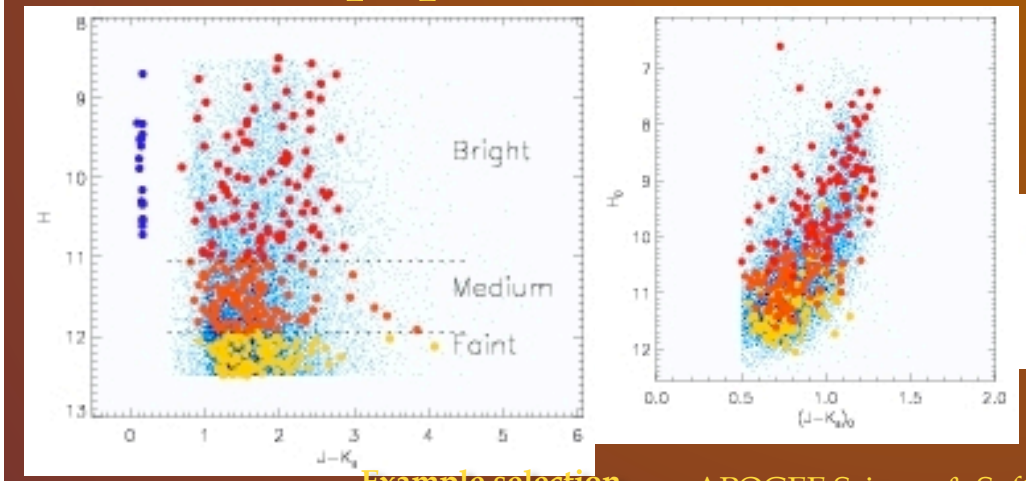
- Comparison of reddened and dereddened selections
- $(J\text{-}K_s)_0 > 0.5$ mag found to be most efficient and reproducible



Target Selection

Colors & Magnitudes

- Science targets
  - Estimate $A(K_s)$ with IRAC where available (higher resolution), fill in with WISE
  - $0.5 \leq (J\text{-}K_s)_0 \leq$??? (no upper color limit [yet])
  - 3 flexible magnitude divisions, for consistent sampling of populations with different brightness distributions



Example selection at (*l*,*b*) = (60,0)°