Dust in the Milky Way and Local Group

Maps and Models and Constraints, Oh My!

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Johns Hopkins University

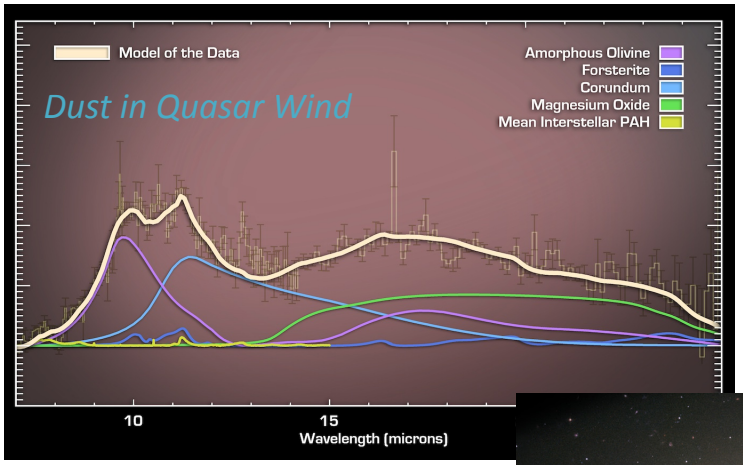
Wide-Field Infrared Surveys: Science and Techniques

17-20 Nov 2014

Pasadena, CA

Dust Basics

- Ubiquitous in the Universe
- Repository of metals and chemical pathways



F. Kemper

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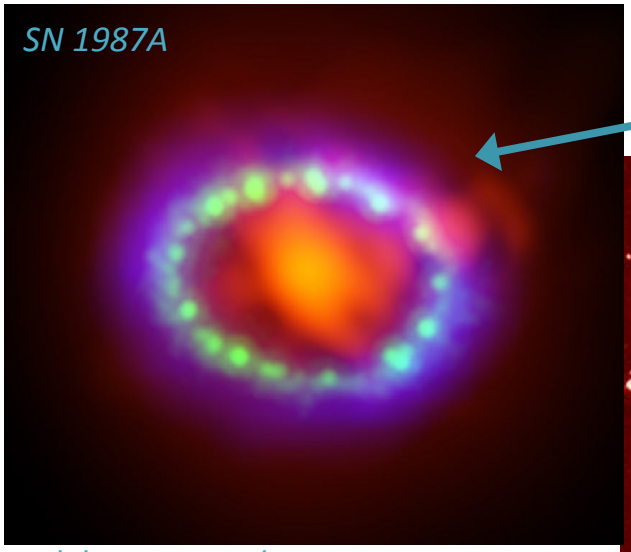
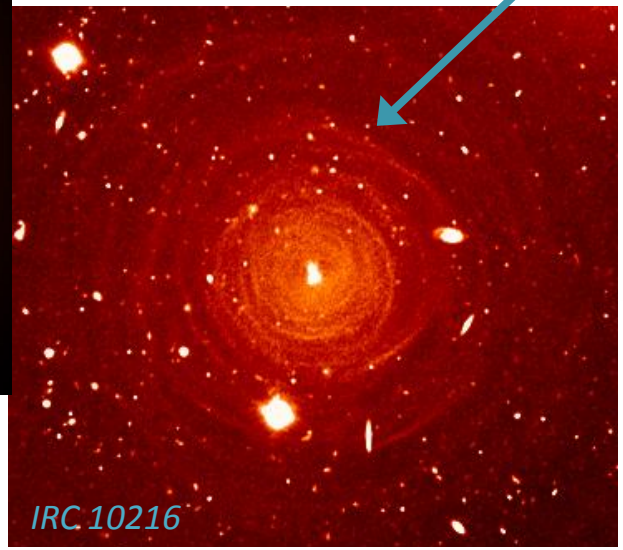
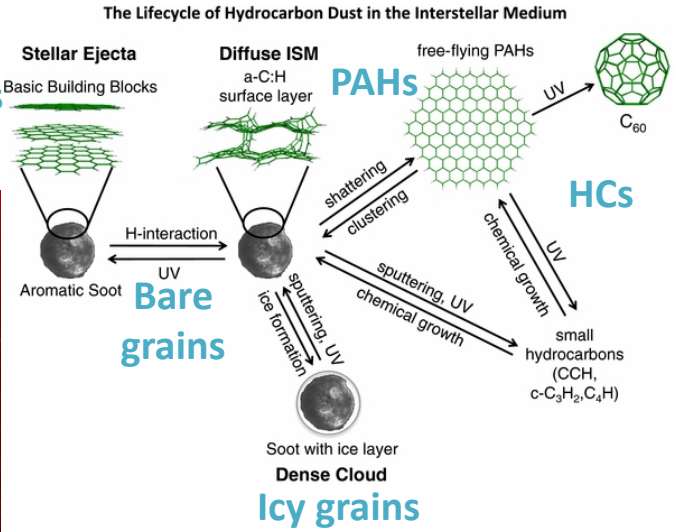


Indebetouw et al.





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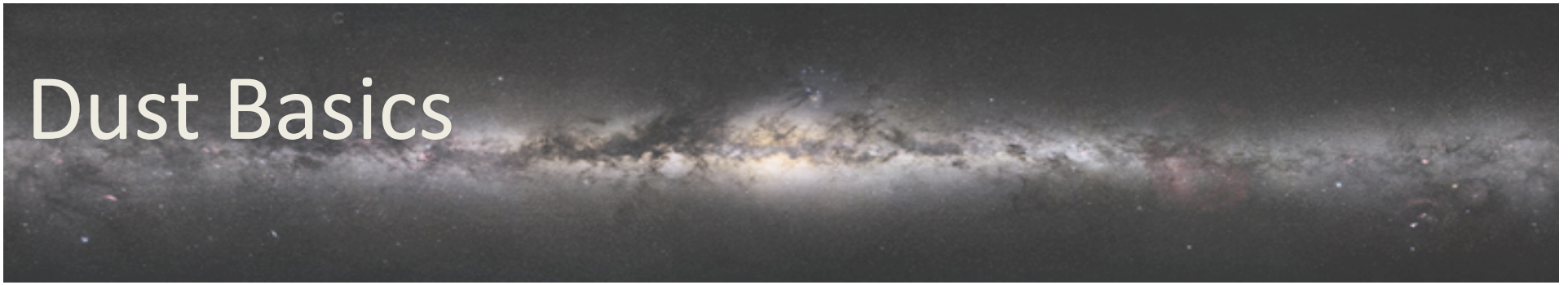
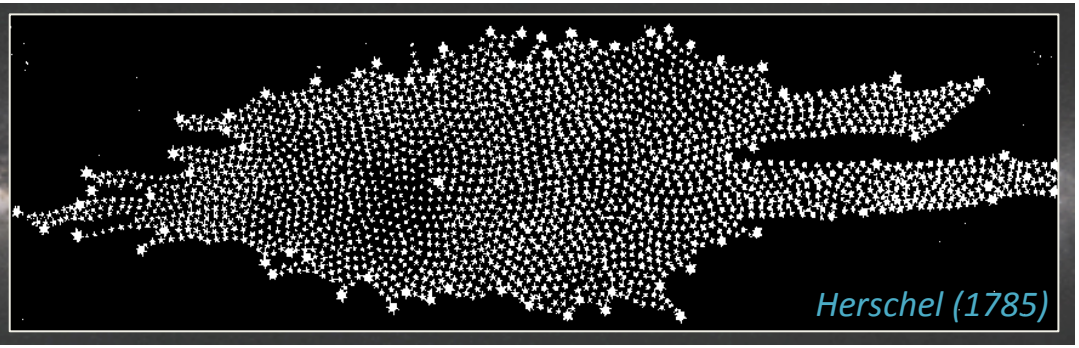


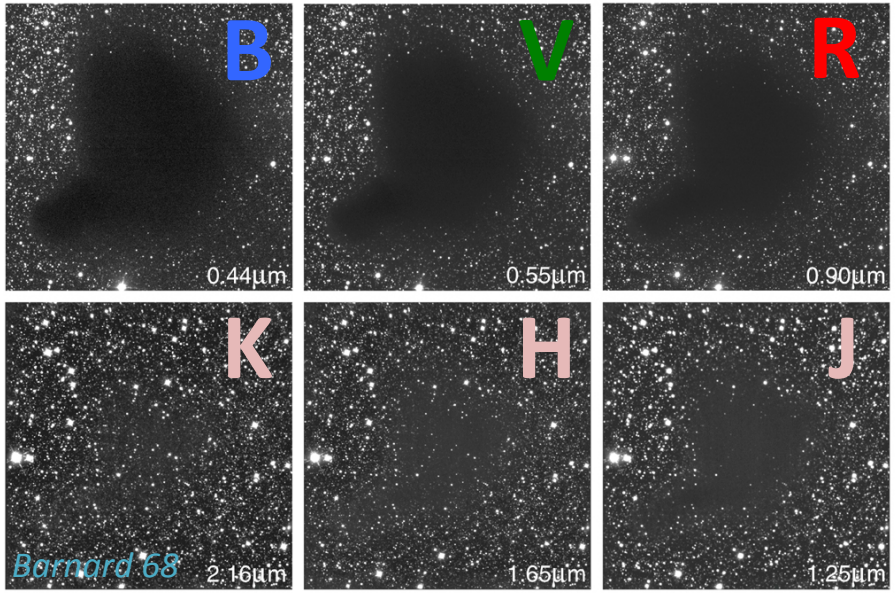
- Ubiquitous in the Universe
- Repository of metals and chemical pathways
- Formation in SNe, evolved stars, ISM
- Grain size reflects formation and evolution
- Extinction curve: Indebetouw slides

Extinction

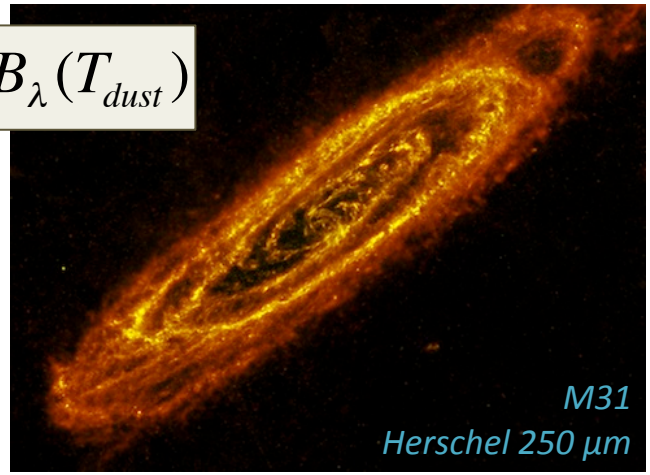


$$m_\lambda - M_\lambda = \mu = 5 \log(d) - 5 + A_\lambda$$

- absorption vs. emission measures
- 2-D vs. 3-D maps



$$F_\lambda \propto N_{dust} Q_\lambda B_\lambda(T_{dust})$$



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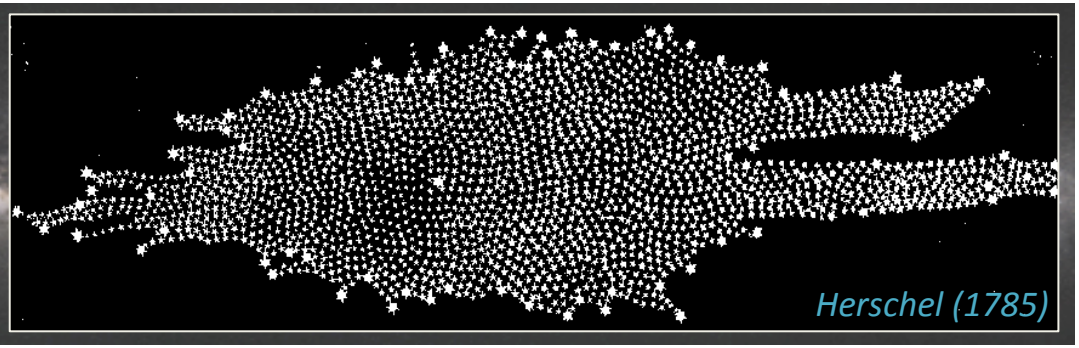
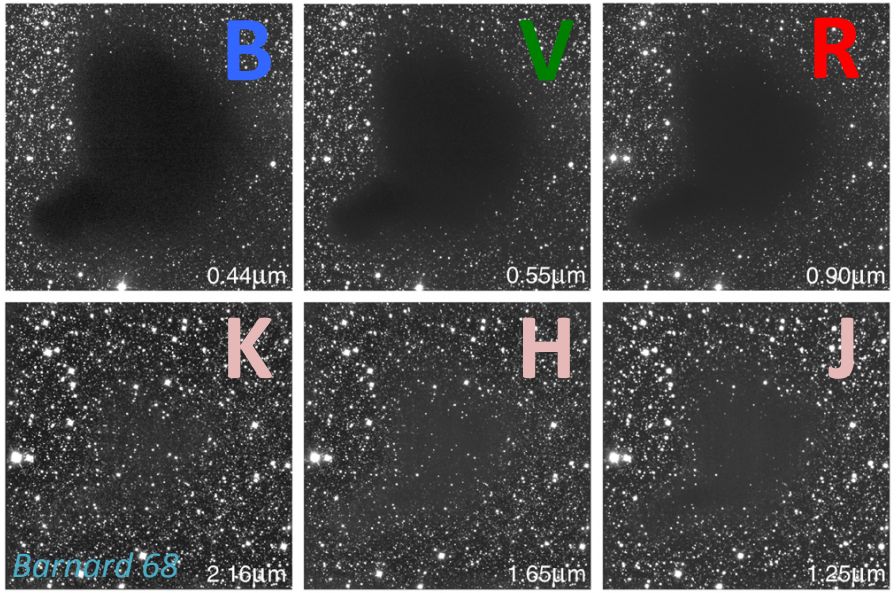


$$m_\lambda - M_\lambda = \mu = 5 \log(d) - 5 + A_\lambda$$

- absorption vs. emission measures
- 2-D vs. 3-D maps
- basic approaches:
  - SED modeling
  - dust proxies
  - statistical distributions



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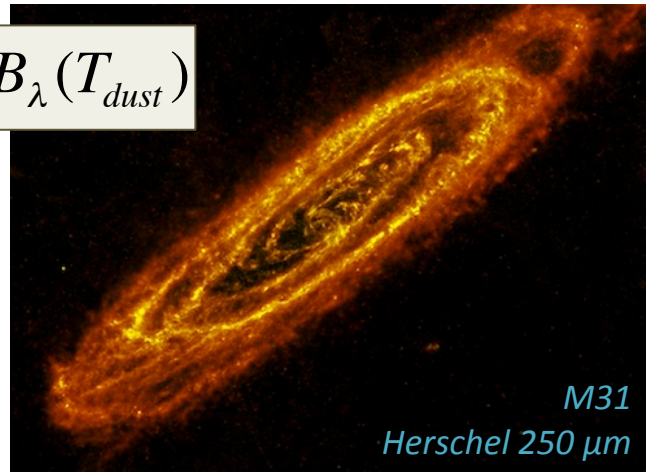
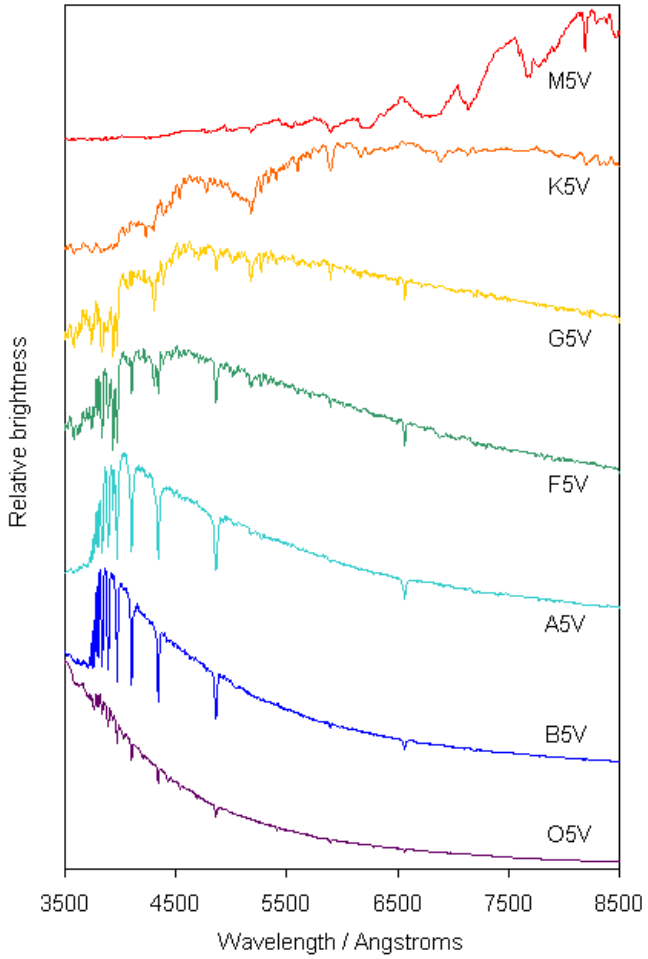


Extinction Mapping: SED Modeling

- Gives A_0 measurements for each individual source



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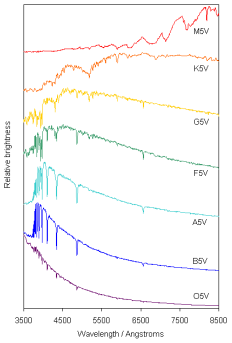

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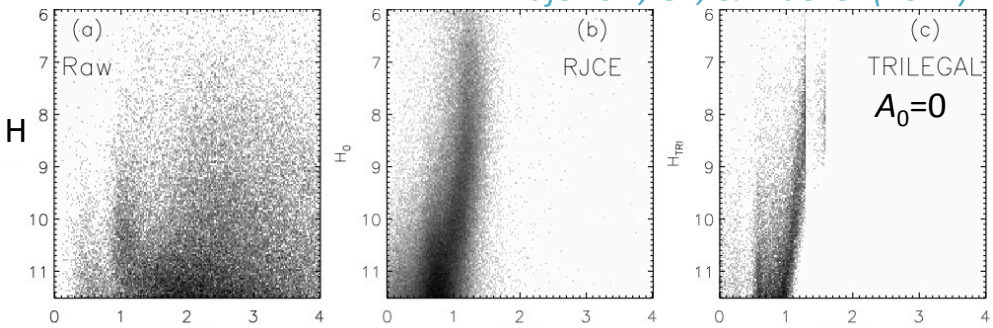
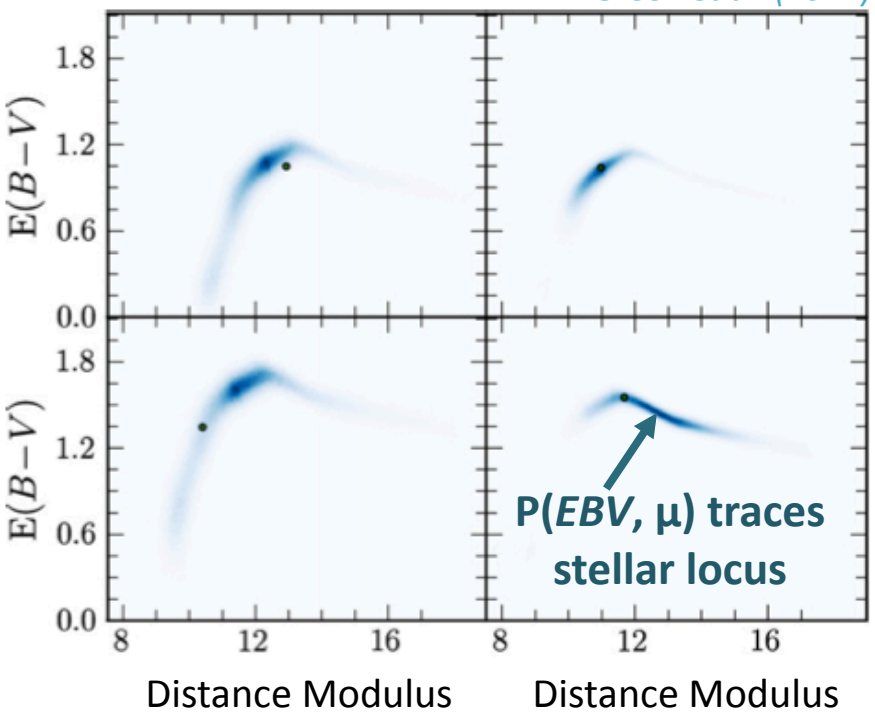
Color Excesses:

Majewski, GZ, & Nidever (2011)

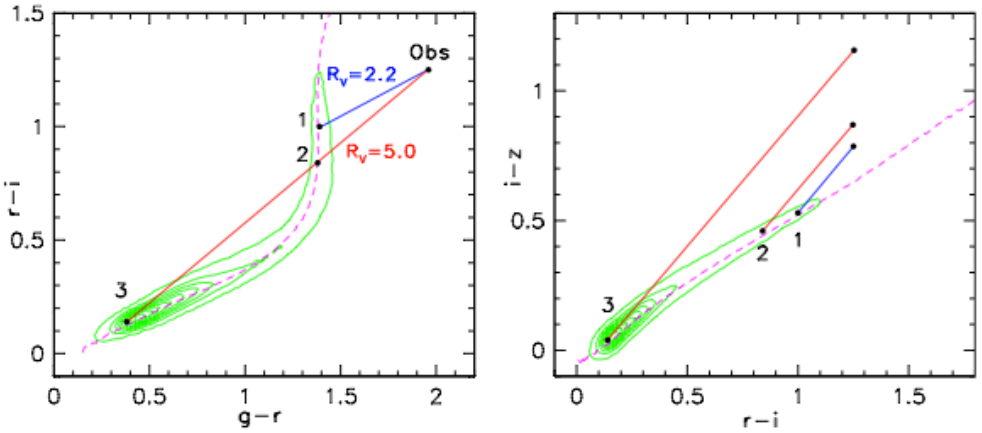


Bayesian Inference:

Green et al. (2014)



Direct Fitting of SED+A_0 (+R_0+…):



Berry et al. (2012)

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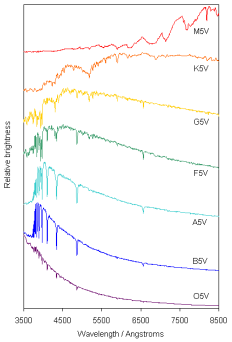

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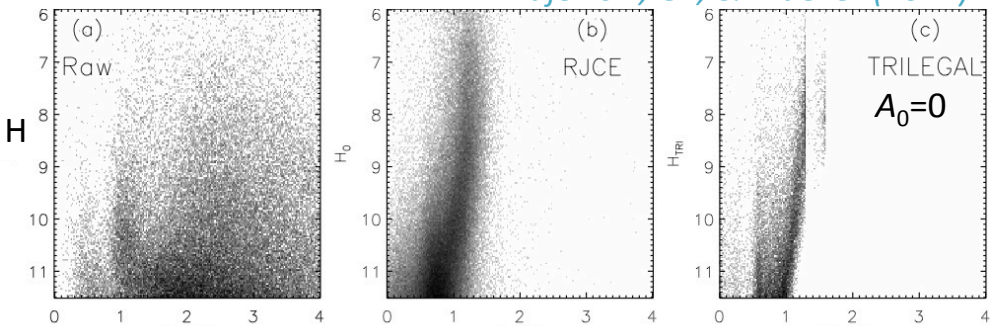

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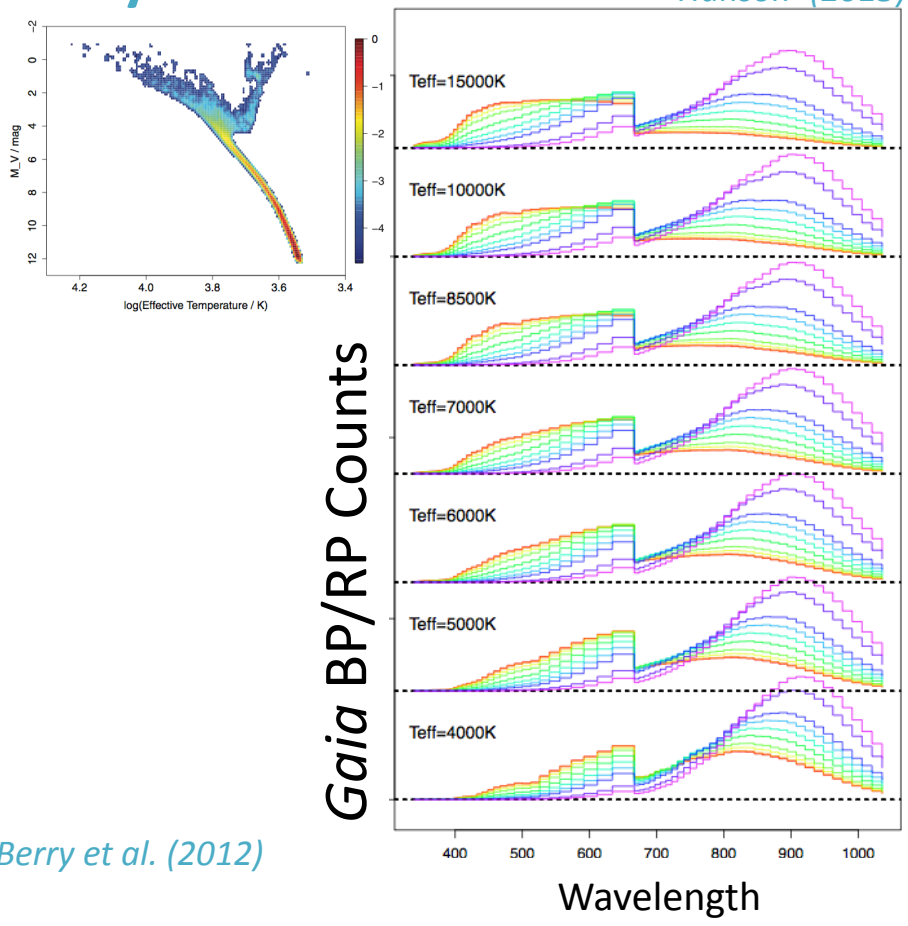
Bailer-Jones (2011), Hanson+(2013)



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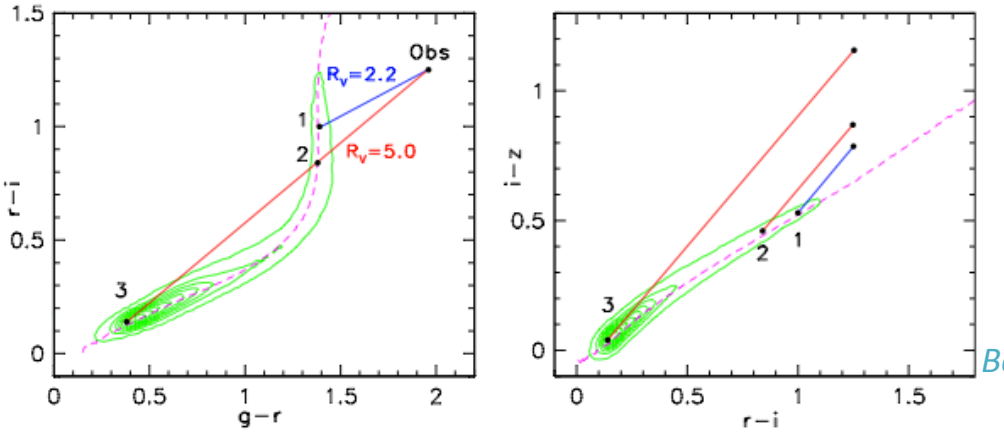

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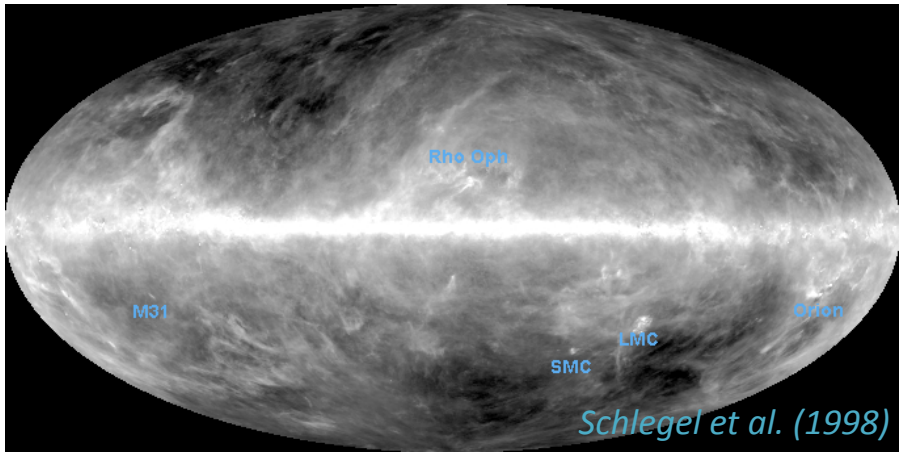
Extinction Mapping: Dust Proxies

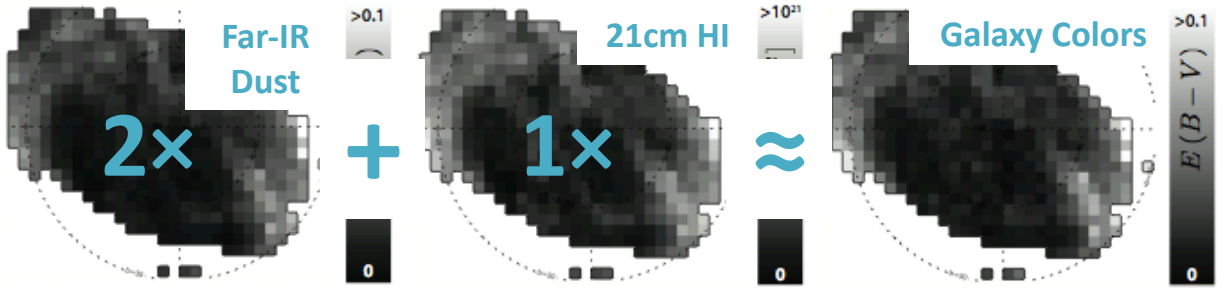
- Using dust- or extinction-correlated tracers
- Correlation factors contain physics

Long-λ Dust Emission:



… + HI Emission:

Peek (2013)



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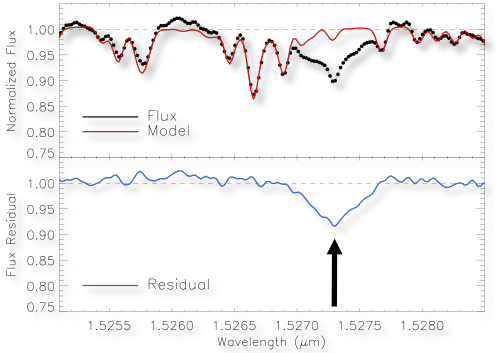

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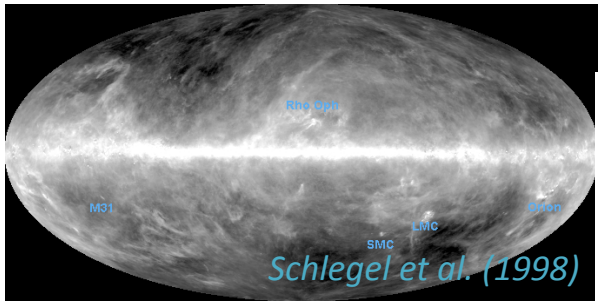

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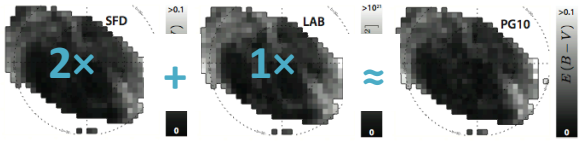
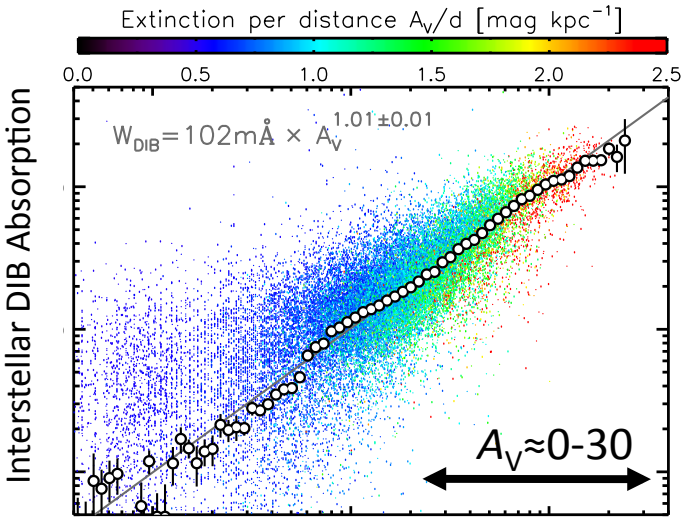
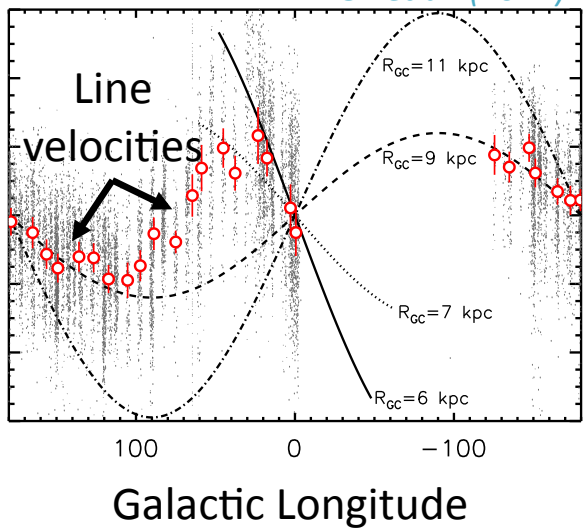


Atomic/Molecular Absorption:



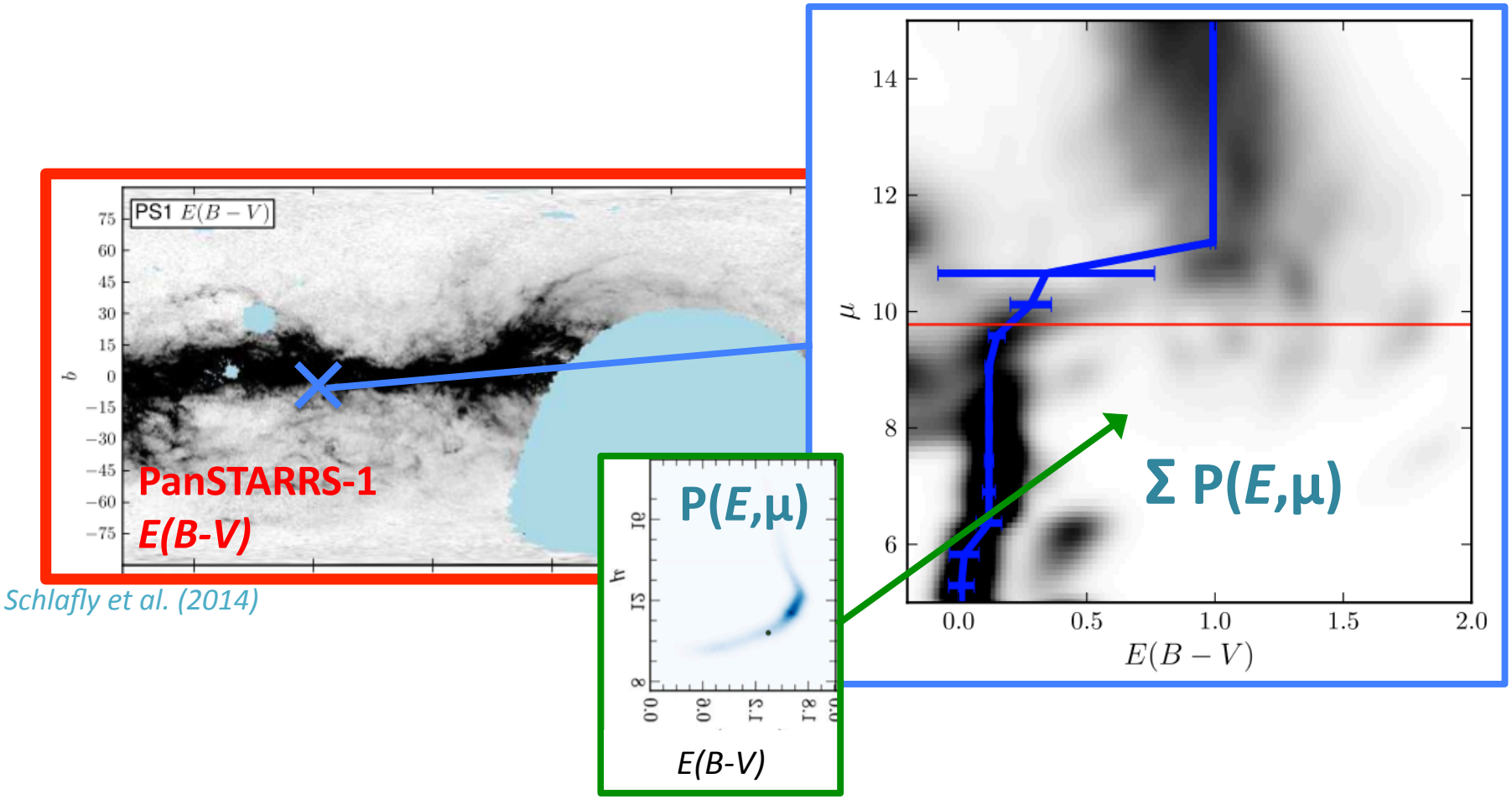
GZ et al. (2014)



Absorption line tracers add the dimension of velocity.

Extinction Mapping: Statistical

- 2D/3D pixel values determined by ensemble properties -- **powerful**!



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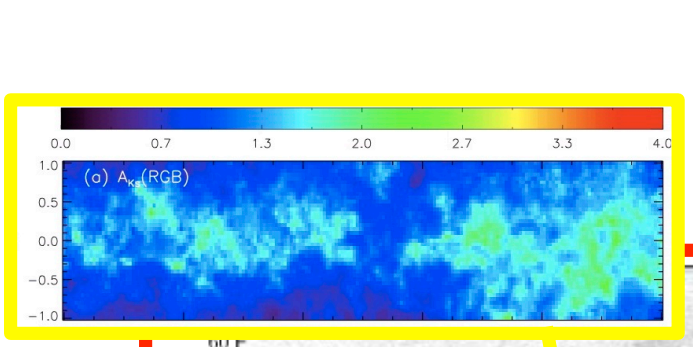

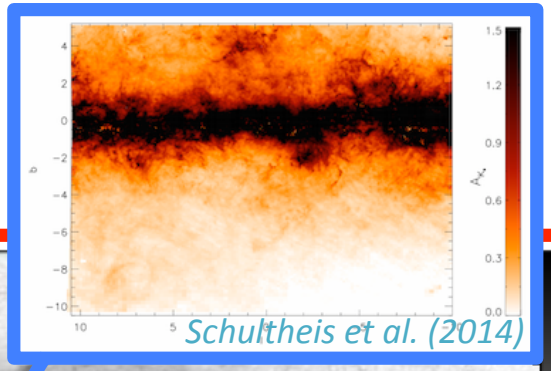

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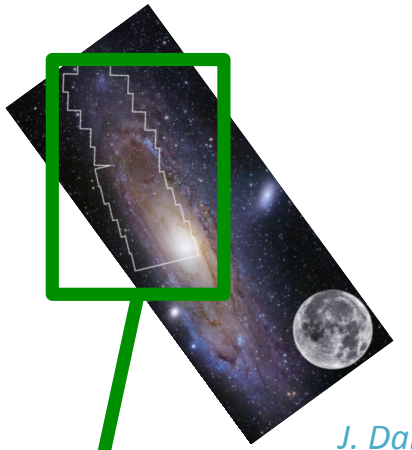

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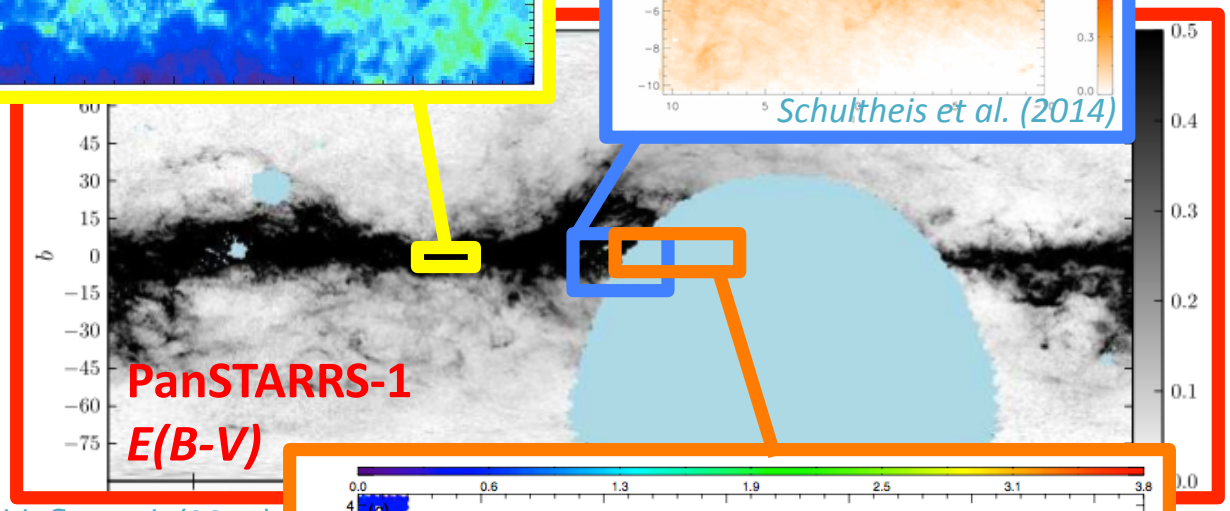

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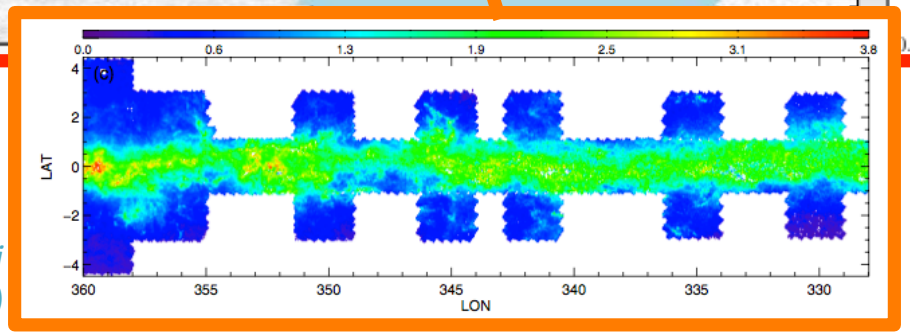
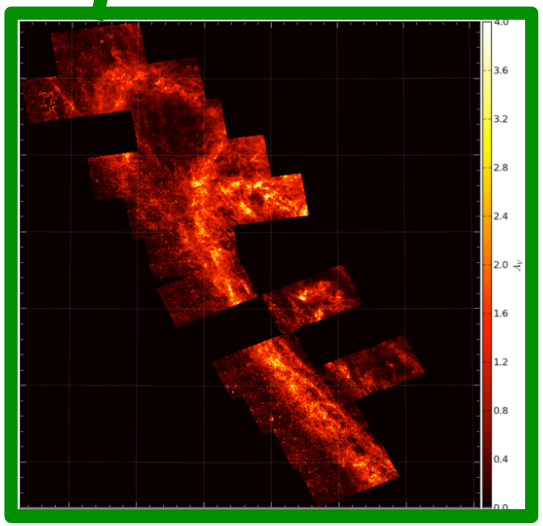


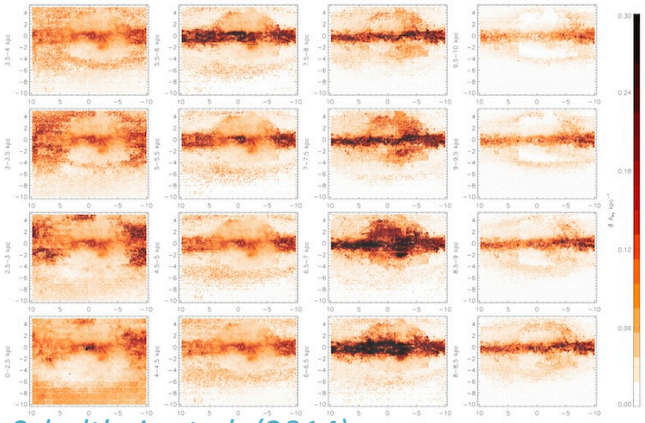
Nidever, GZ, & Majewski (2011)



Extinction Mapping: Statistical

- Multiple ways to convert extinction+distance estimates to 3D maps

Distance/Stellar Type Binning:



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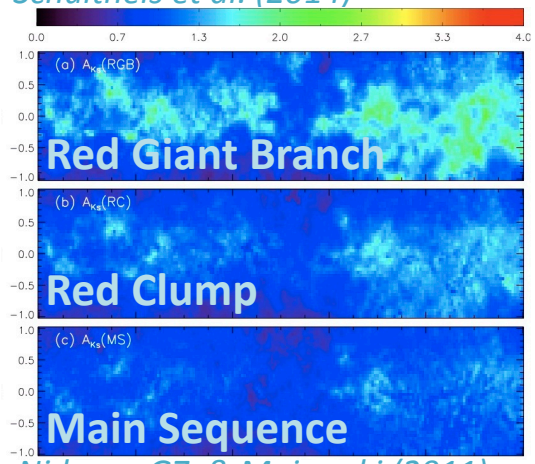

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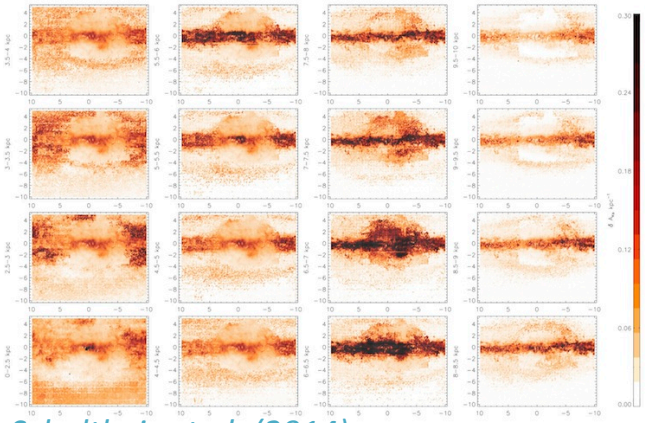

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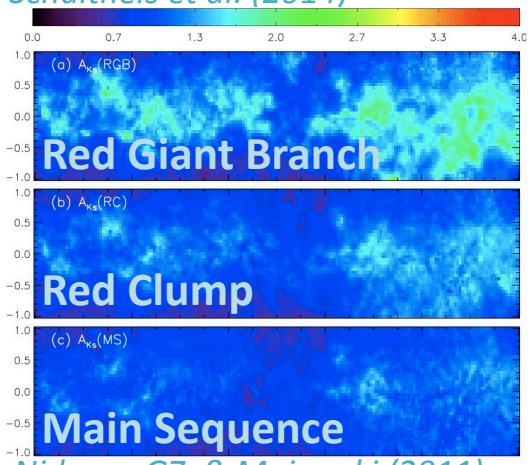

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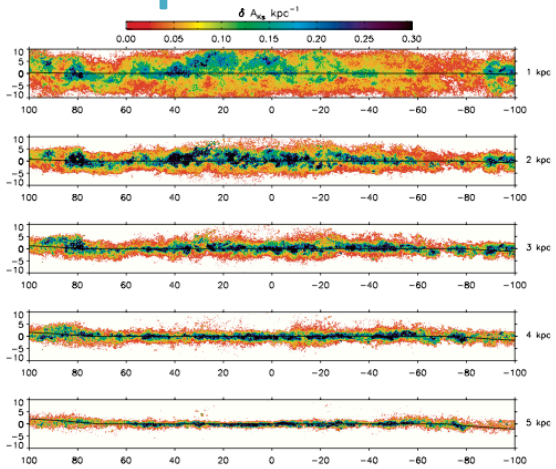
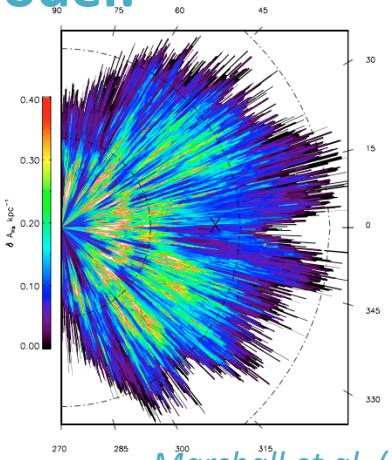
Comparison to 3D Model:





Marshall et al. (2006)

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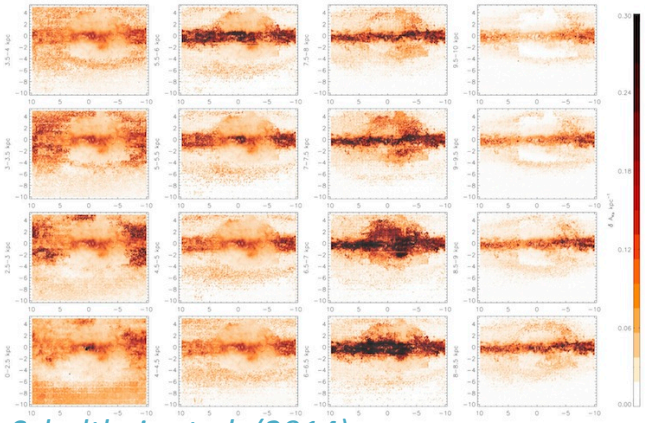

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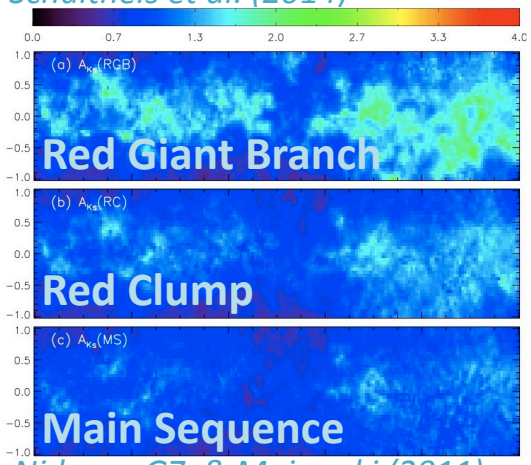

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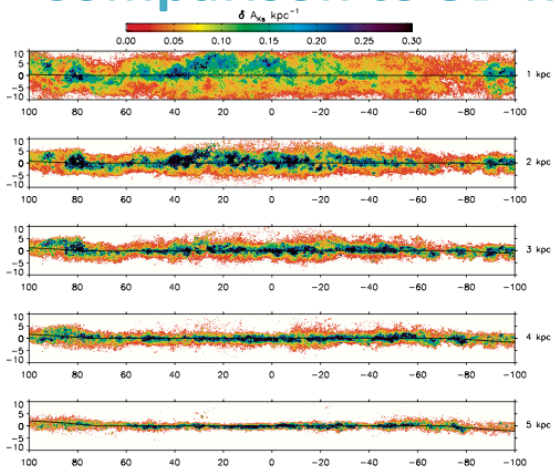

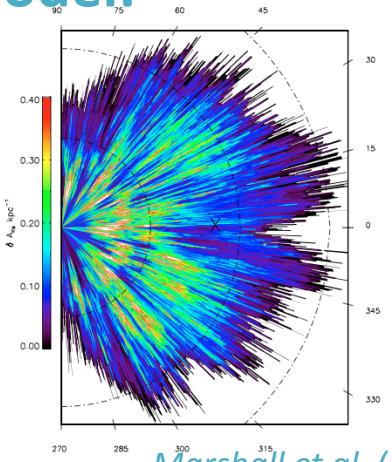

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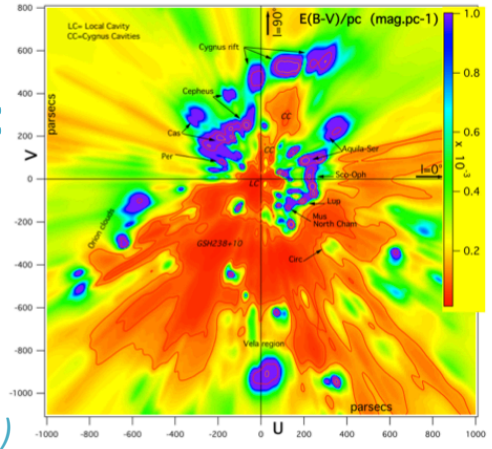
Regularized Inversion:

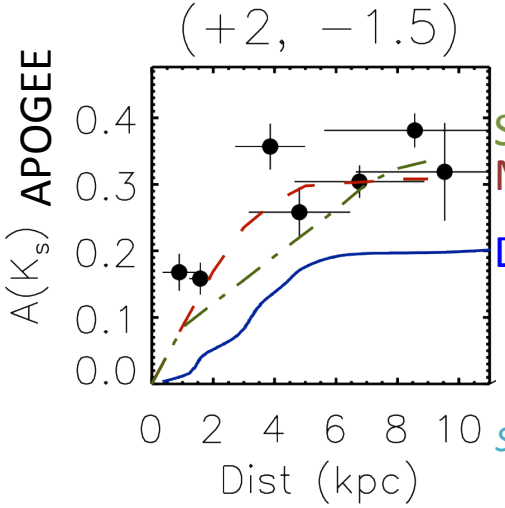


Lallement et al. (2014)

WFIRST

- Bulge microlensing fields
- Star formation regions
- Nearby galaxies
- Add'l bulge+disk fields

3-D extinction structures
Testing large-scale maps/models



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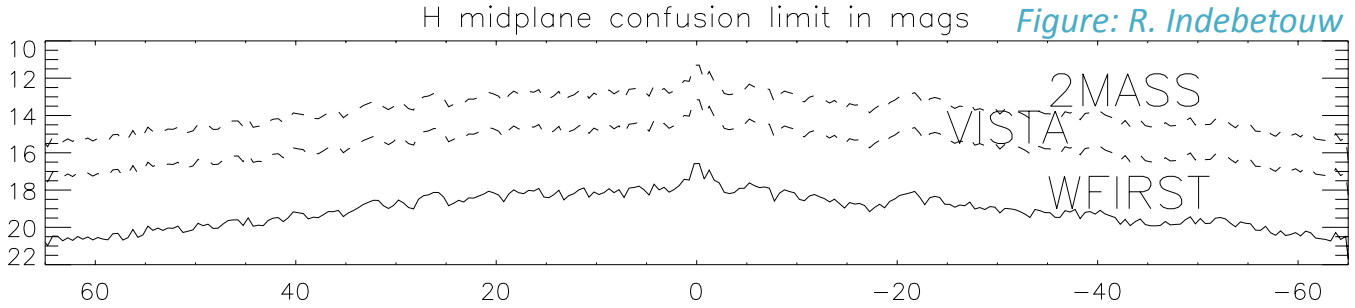


Figure: R. Indebetouw

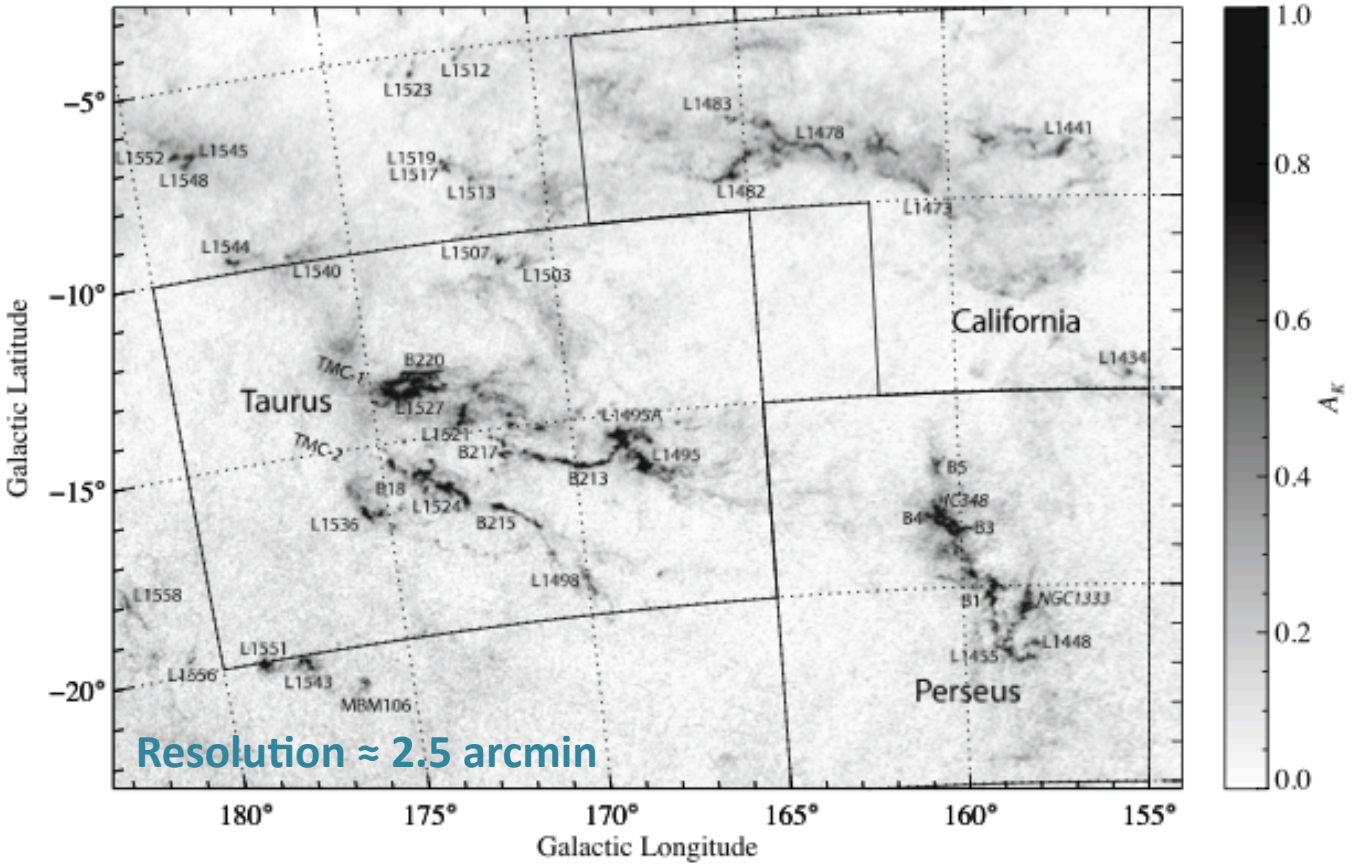
WFIRST

- Bulge microlensing fields
- Star formation regions
- Nearby gala
- Add'l bulge-

Peering into the densest cores

High resolution mapping of filamentary structure

Lombardi & Lada (2010)



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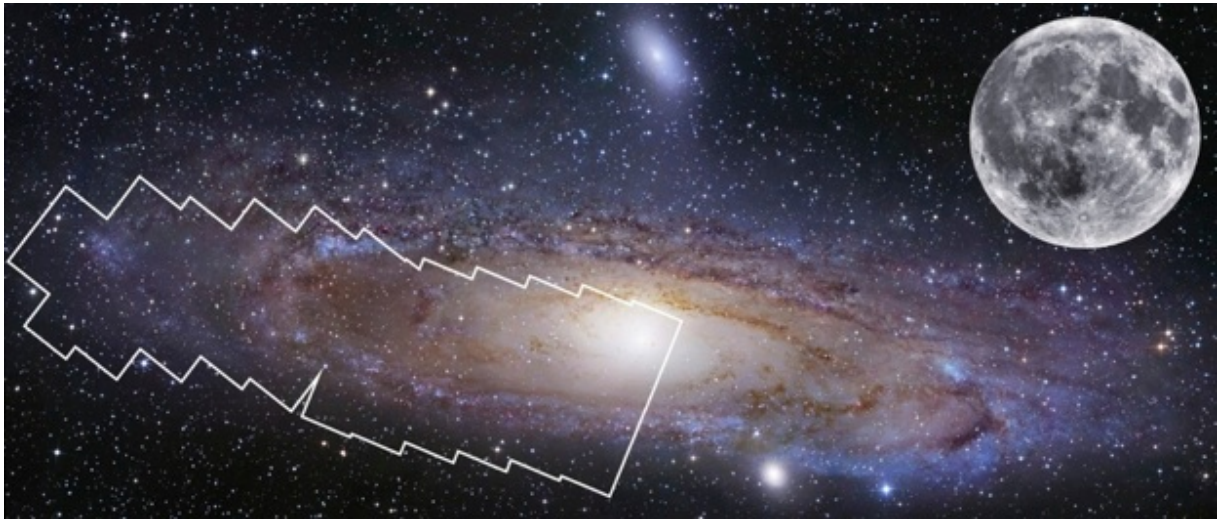

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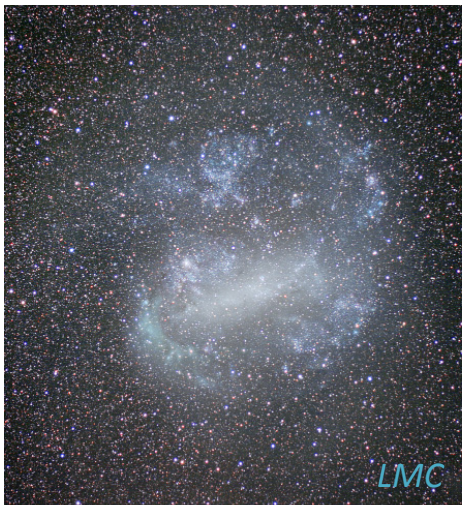

WFIRST

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Using *all* stars to make dust maps