Look up here if you get lost!

Dust *beyond* Disks

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Benjamin Winkel *MPIR*

Gas in Galaxies 2011 *Kloster Seeon*

why dust beyond disks?

dust measurement
in the age of surveys

dust emission in HVCs

reddening in HVCs

reddening
far beyond disks

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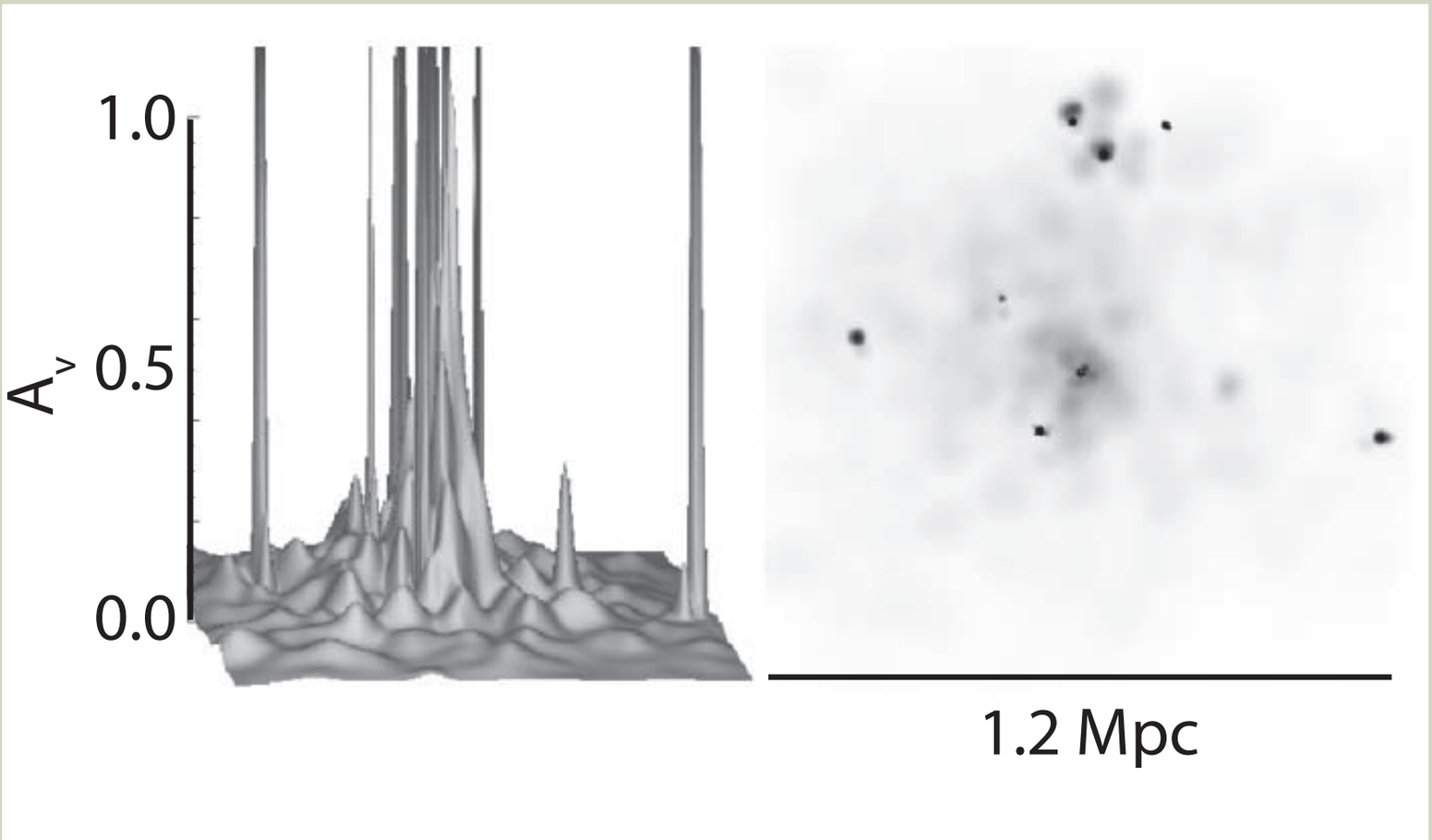
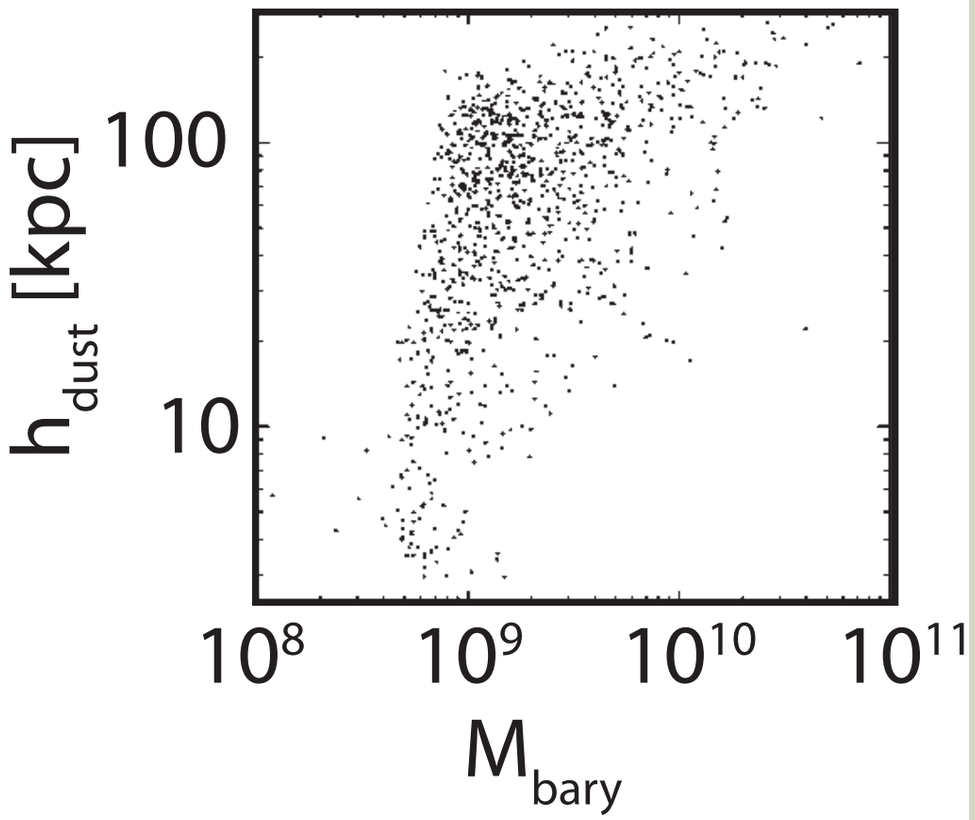
Dust is crucial to feedback and therefore galaxy formation.

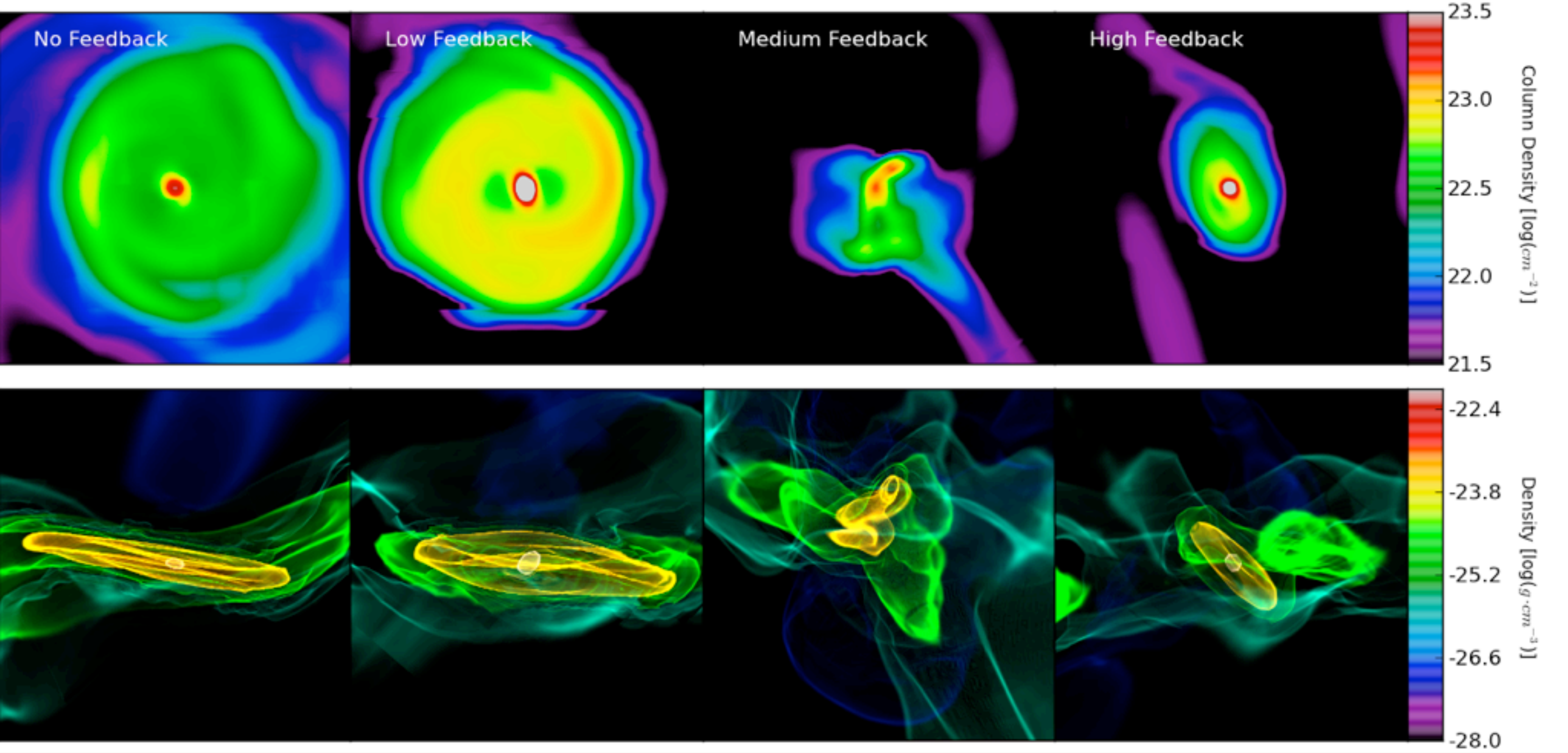
Photon pressure can loft massive amounts of dust.





Aguirre+ 01

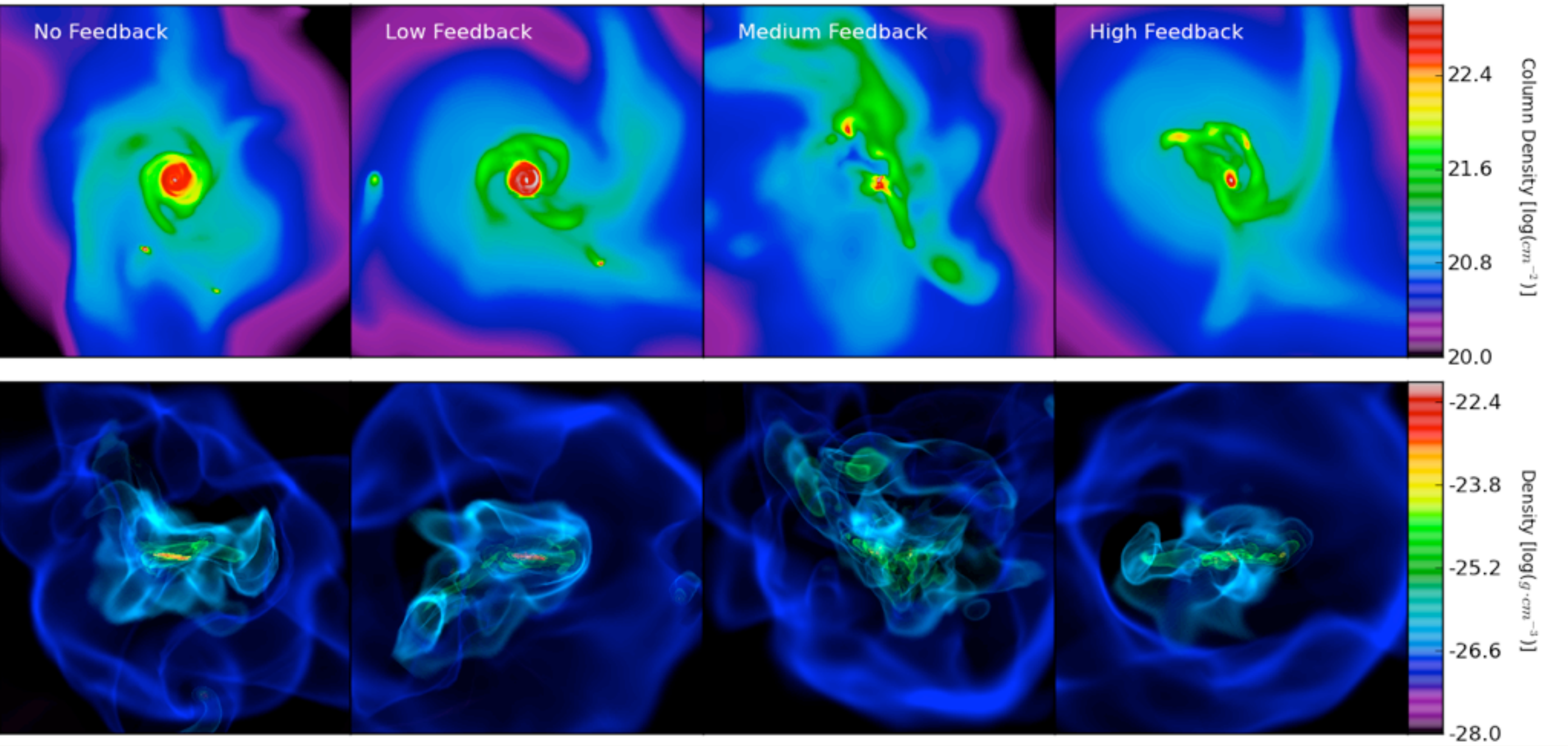
Increased feedback moves gas out of disks.



25 kpc

Hummels & Bryan 12

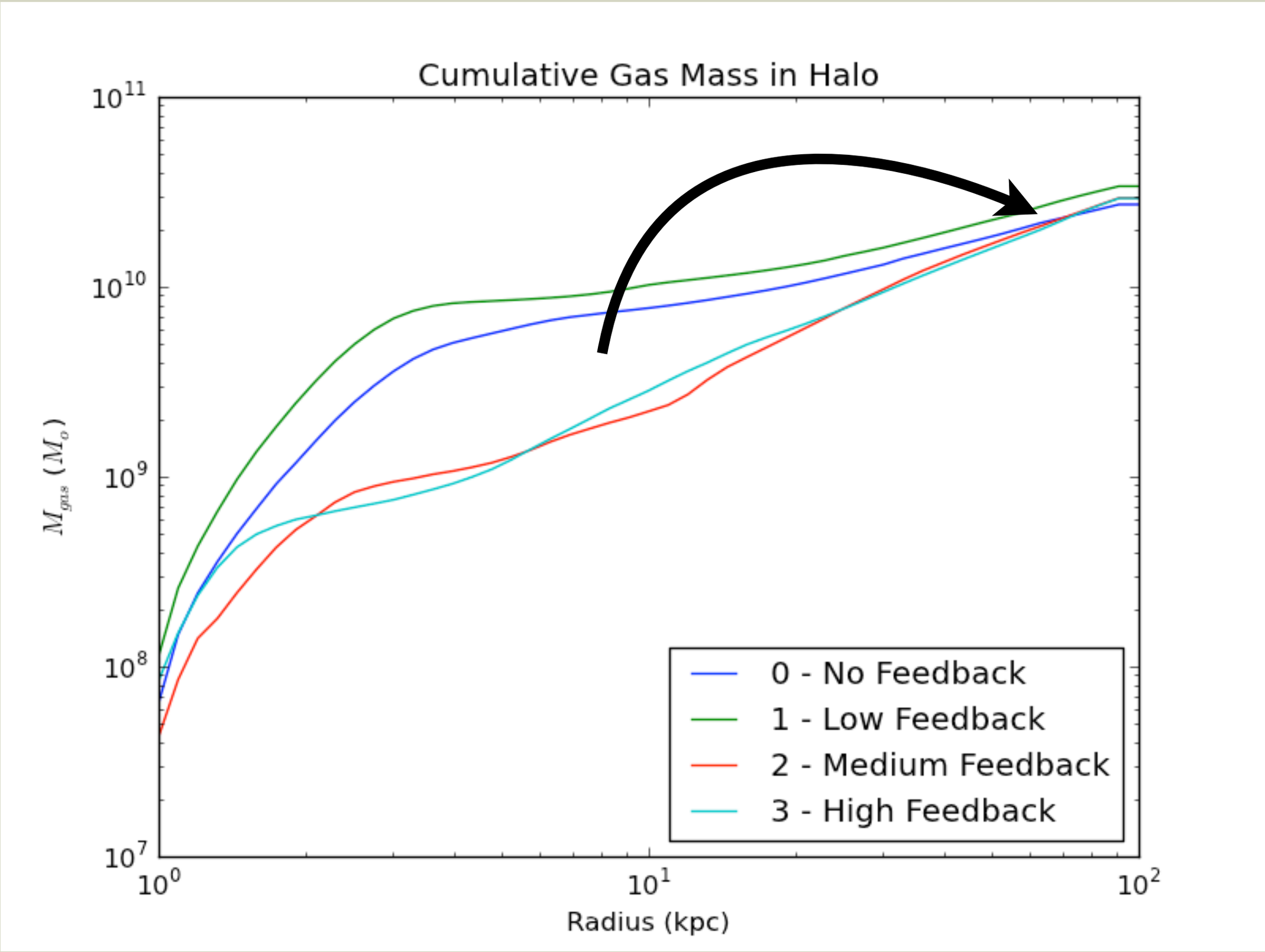
Increased feedback moves gas into halos.



200 kpc

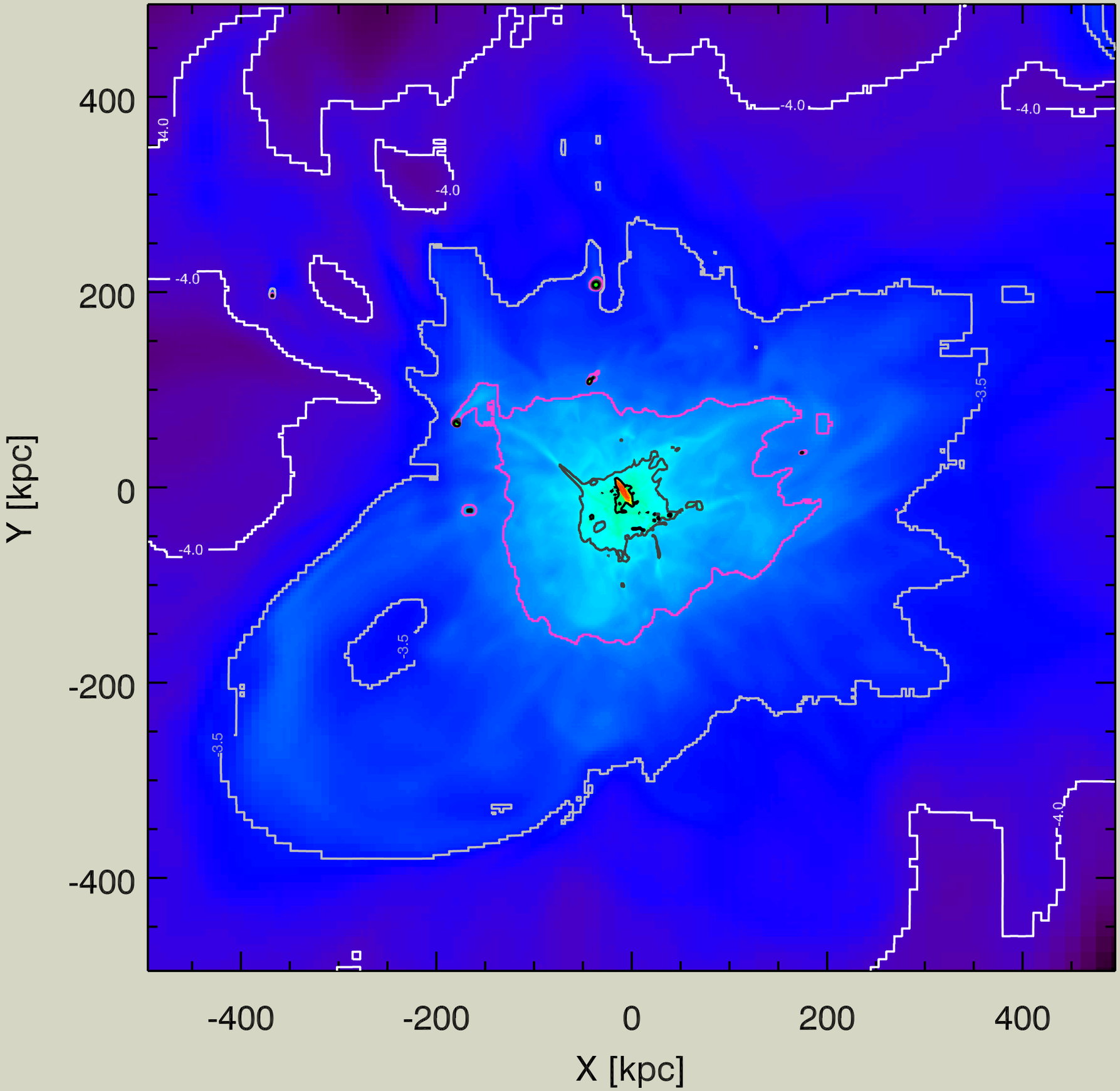
Hummels & Bryan 12

Stronger feedback moves (enriched) gas from disks to halos.



Hummels & Bryan 12

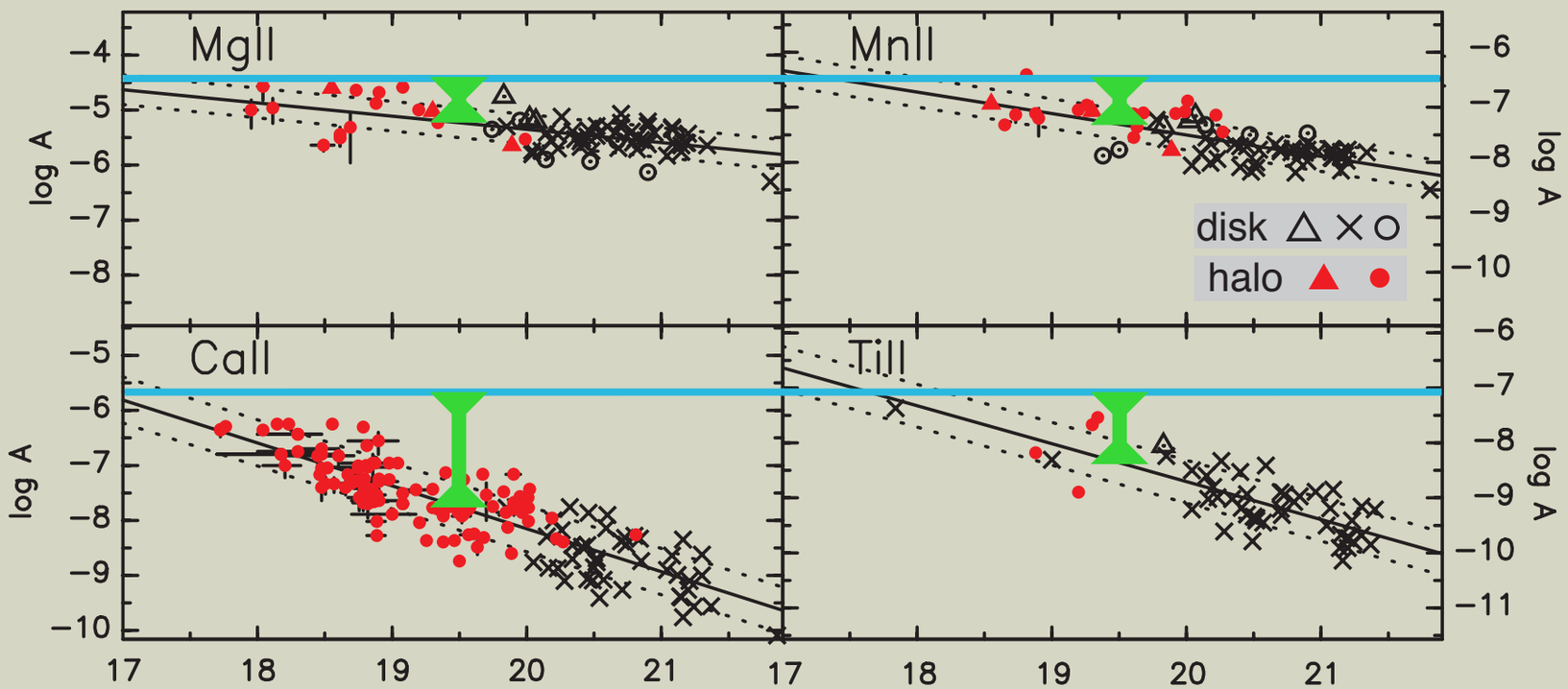
Simulations find detectably enriched gas out to ~100 kpc.

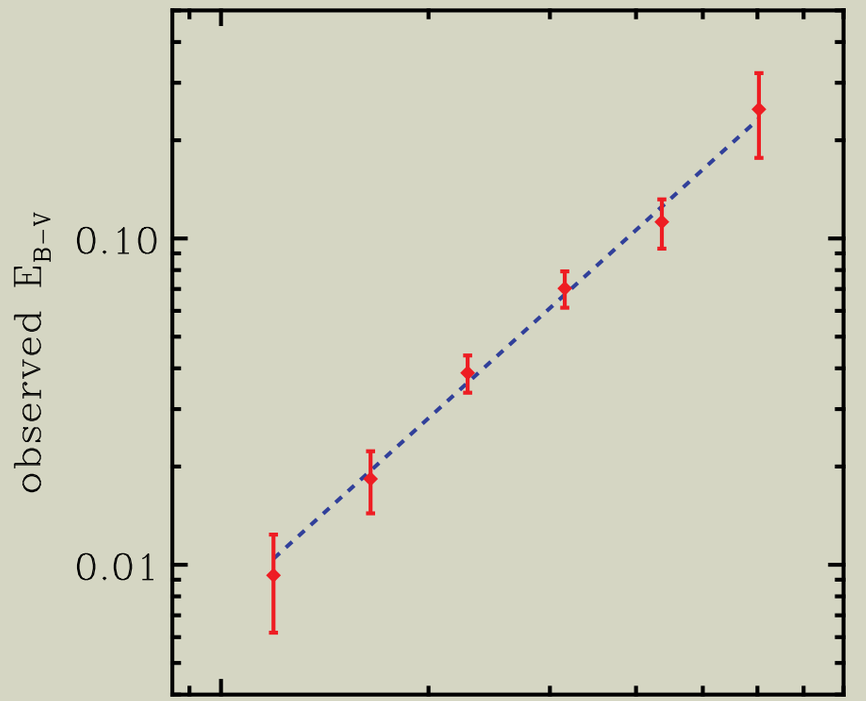


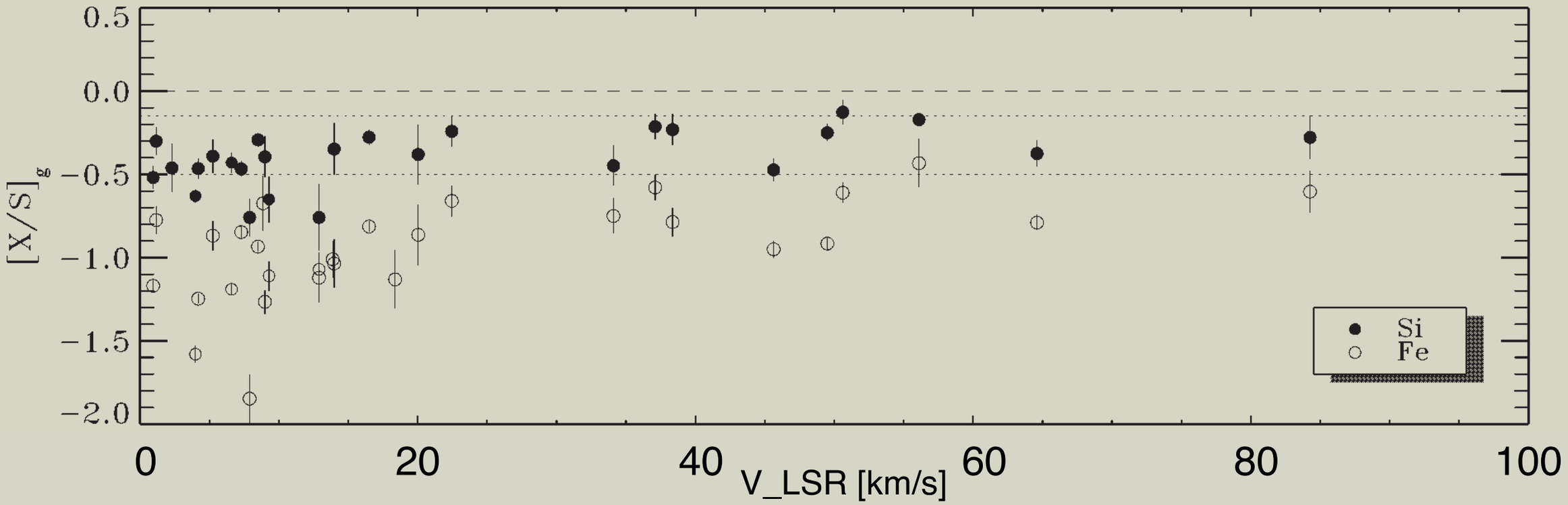
1 mmag reddening

Joung+ 11

Dust *can* survive beyond disks, in some cases.







Fitzpatrick 96, Wakker & Mathis 00, Ménard+ 08

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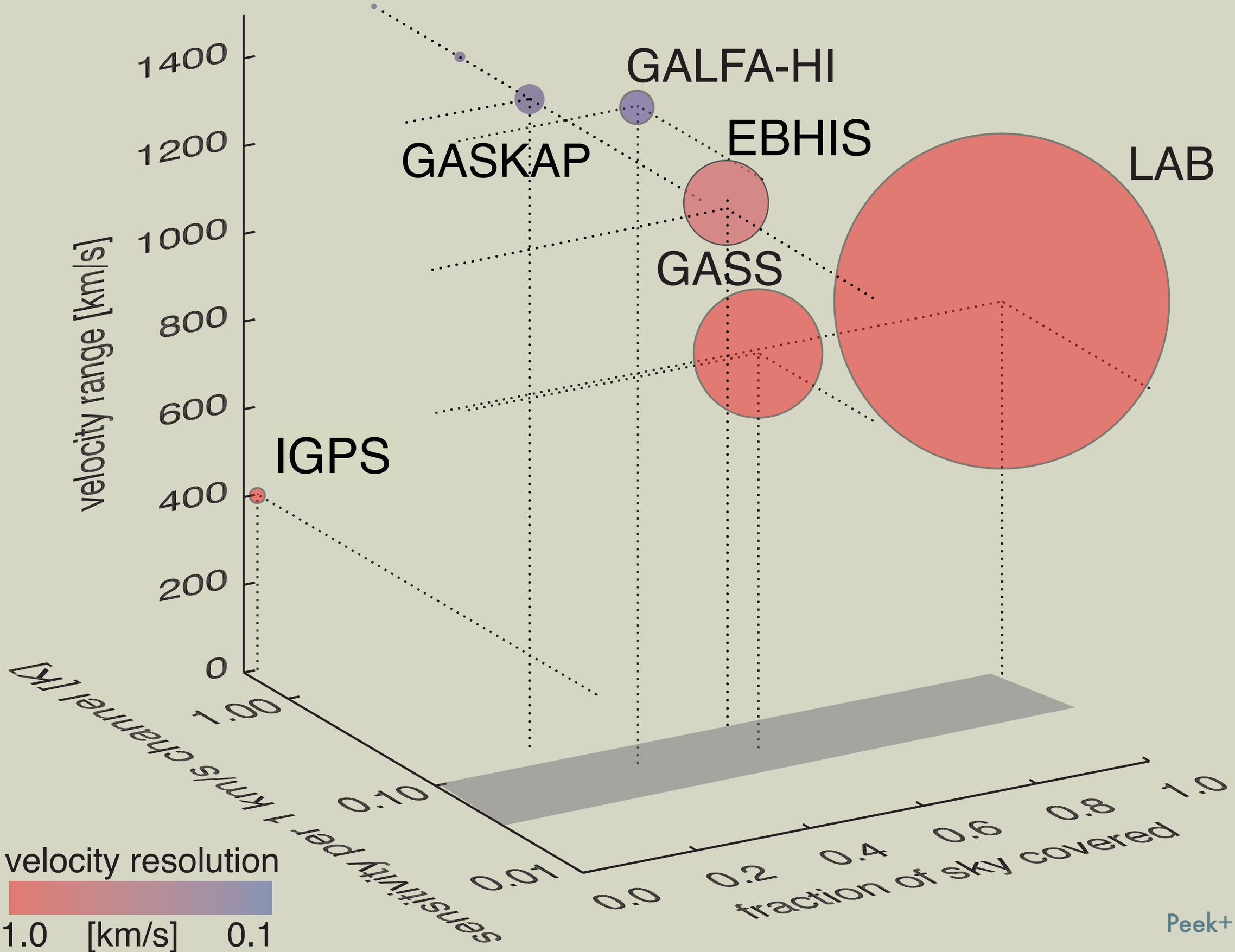
GALFA-HI is an ongoing large area HI survey.

Arecibo 305 m

ALFA

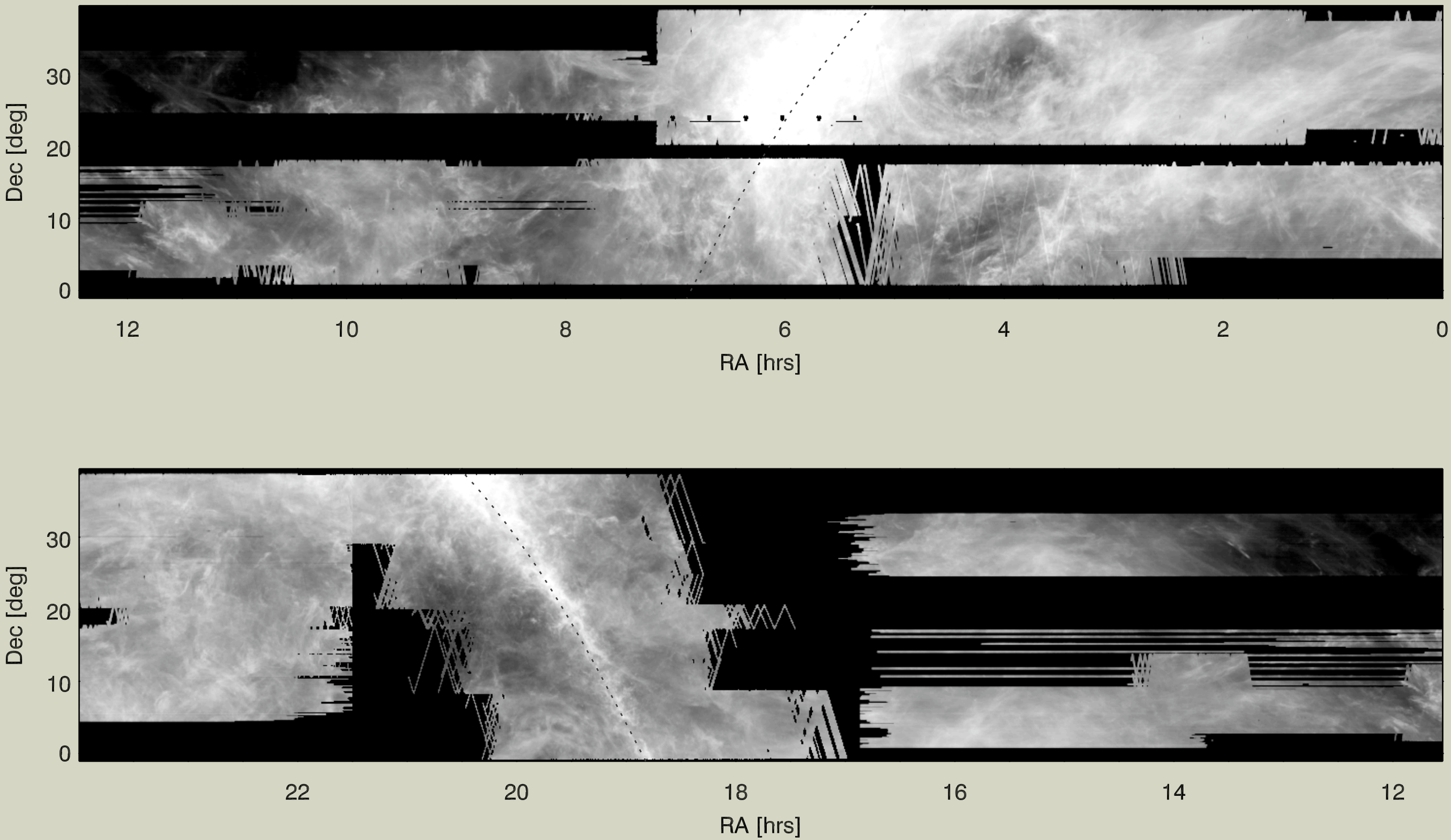
GALSPECT

GALFA-HI is exceptional for the study of extraplanar gas.



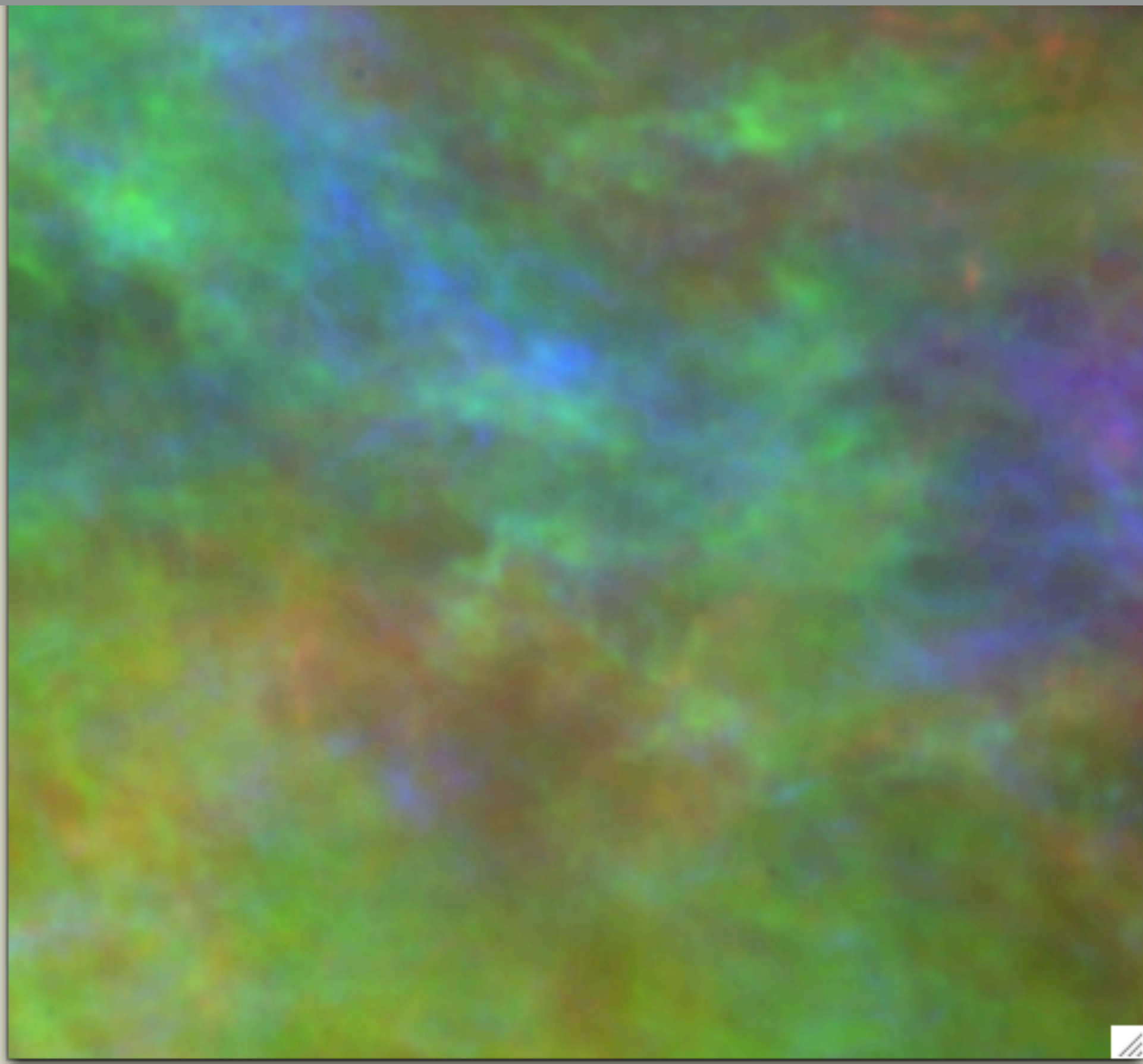
Peek+ 2010

GALFA-HI DR1 is available to the public now!



Peek+ 2011

GALFA-HI matches IRAS and Planck resolutions.



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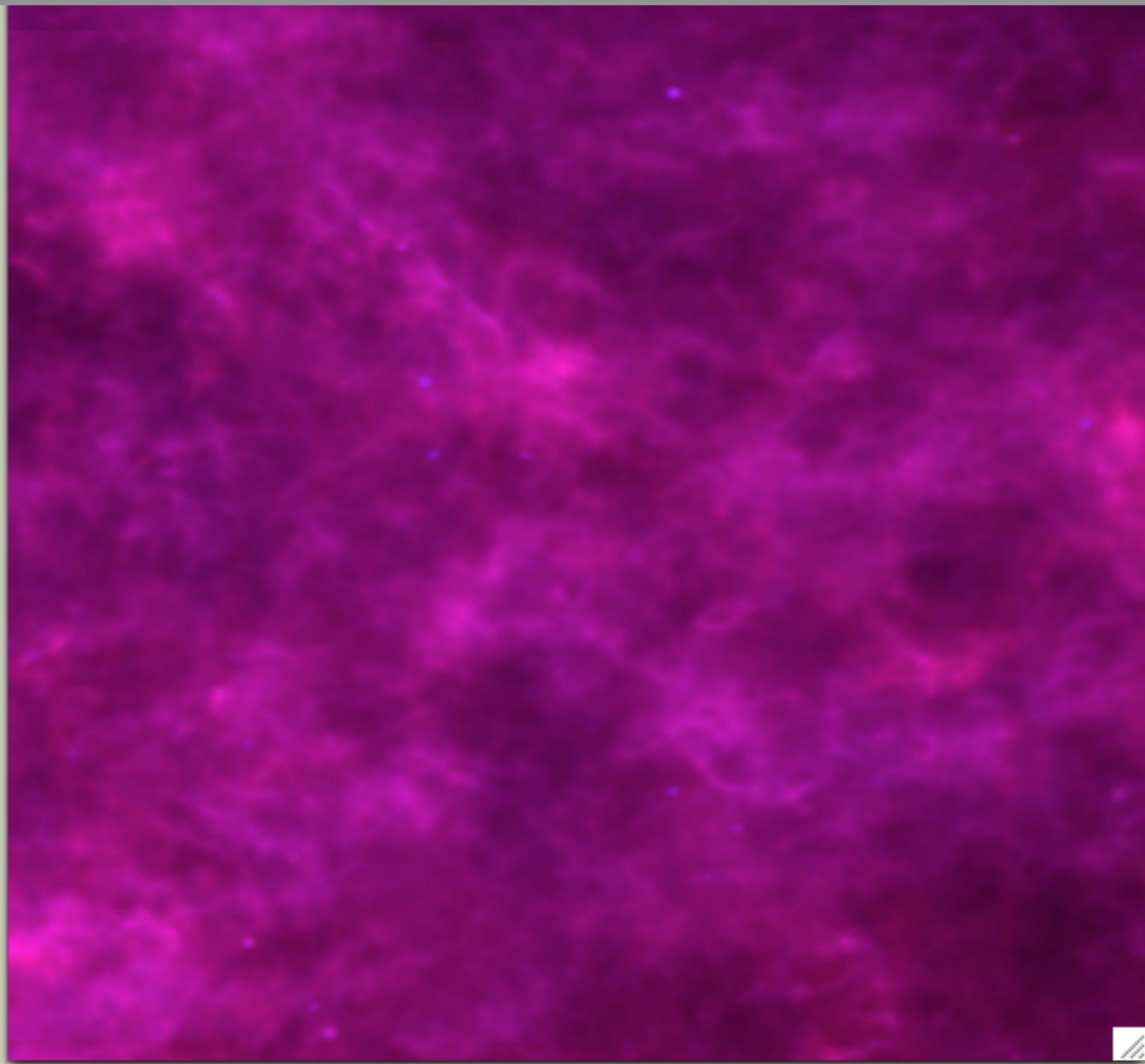
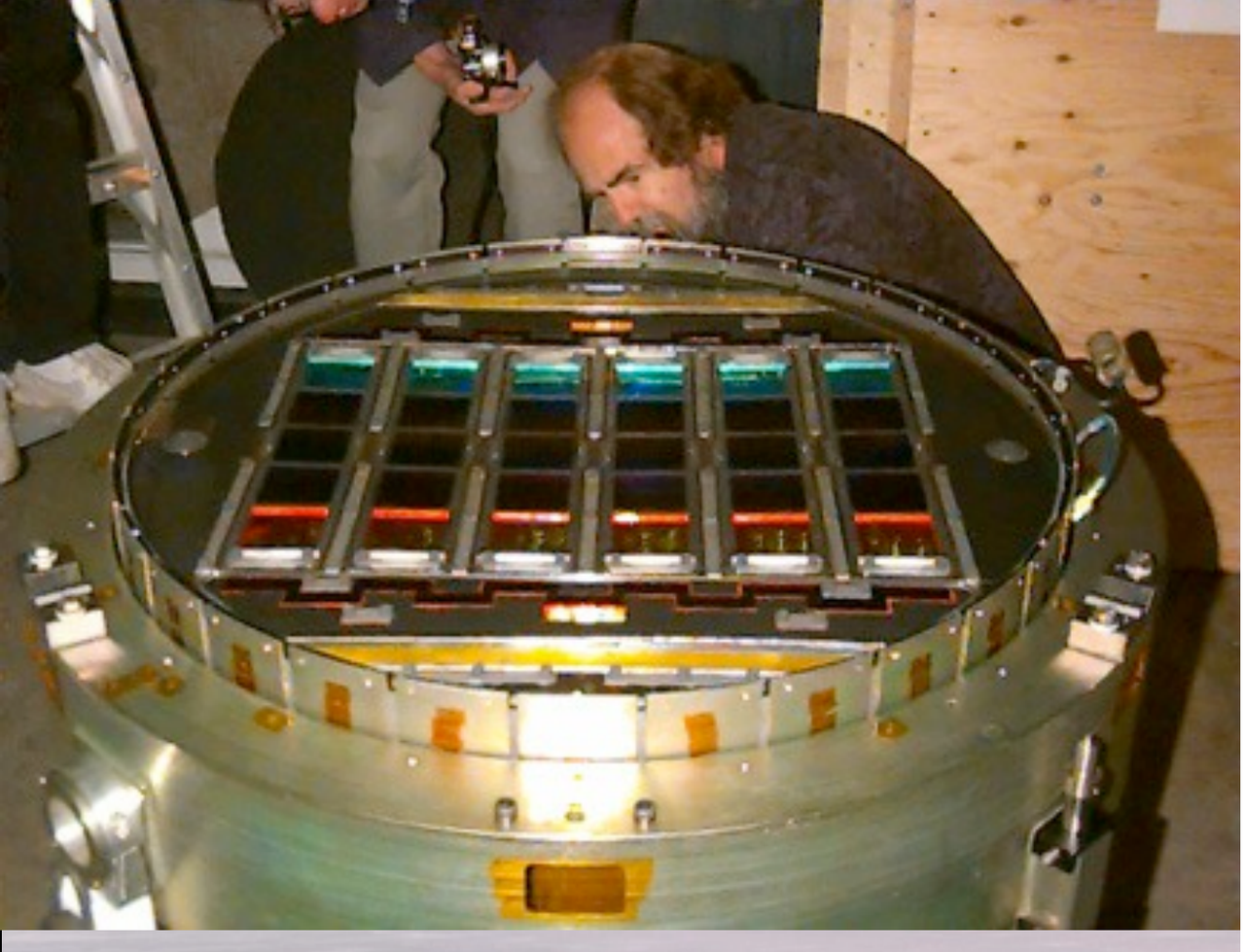
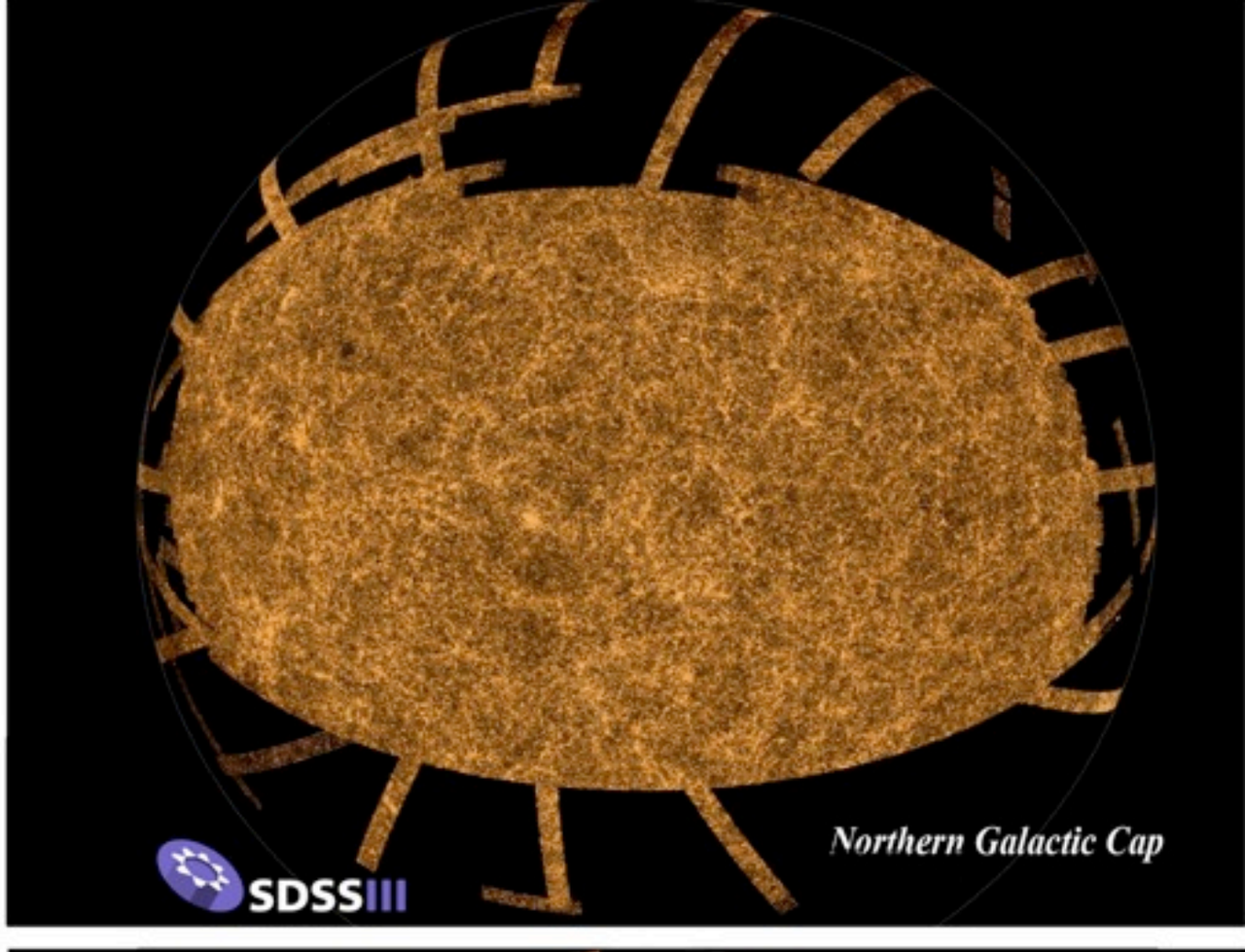
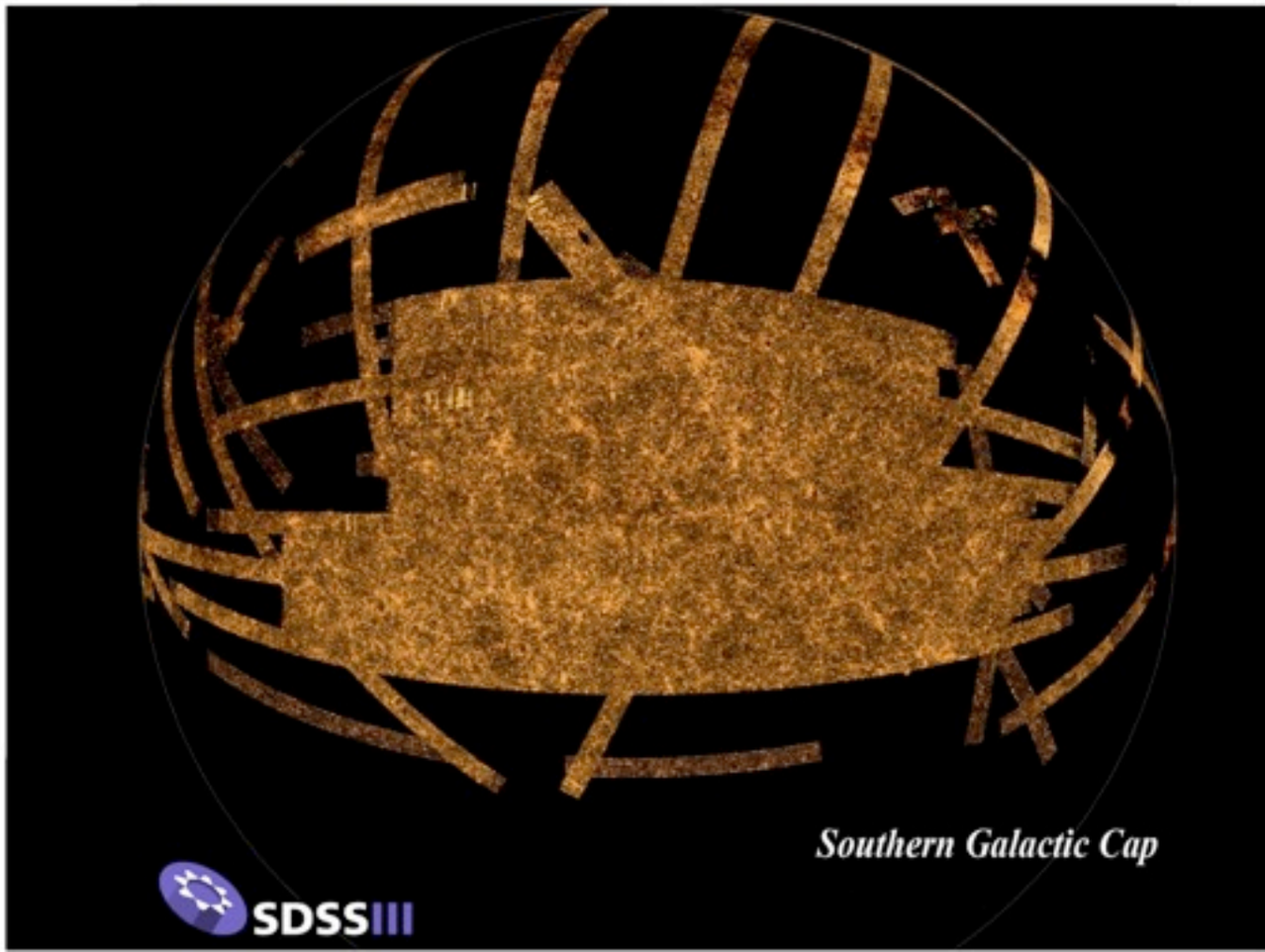





Northern Galactic Cap
SDSSIII


Southern Galactic Cap
SDSSIII

I see your true colors, that's why I love you

Standard Candle:

near

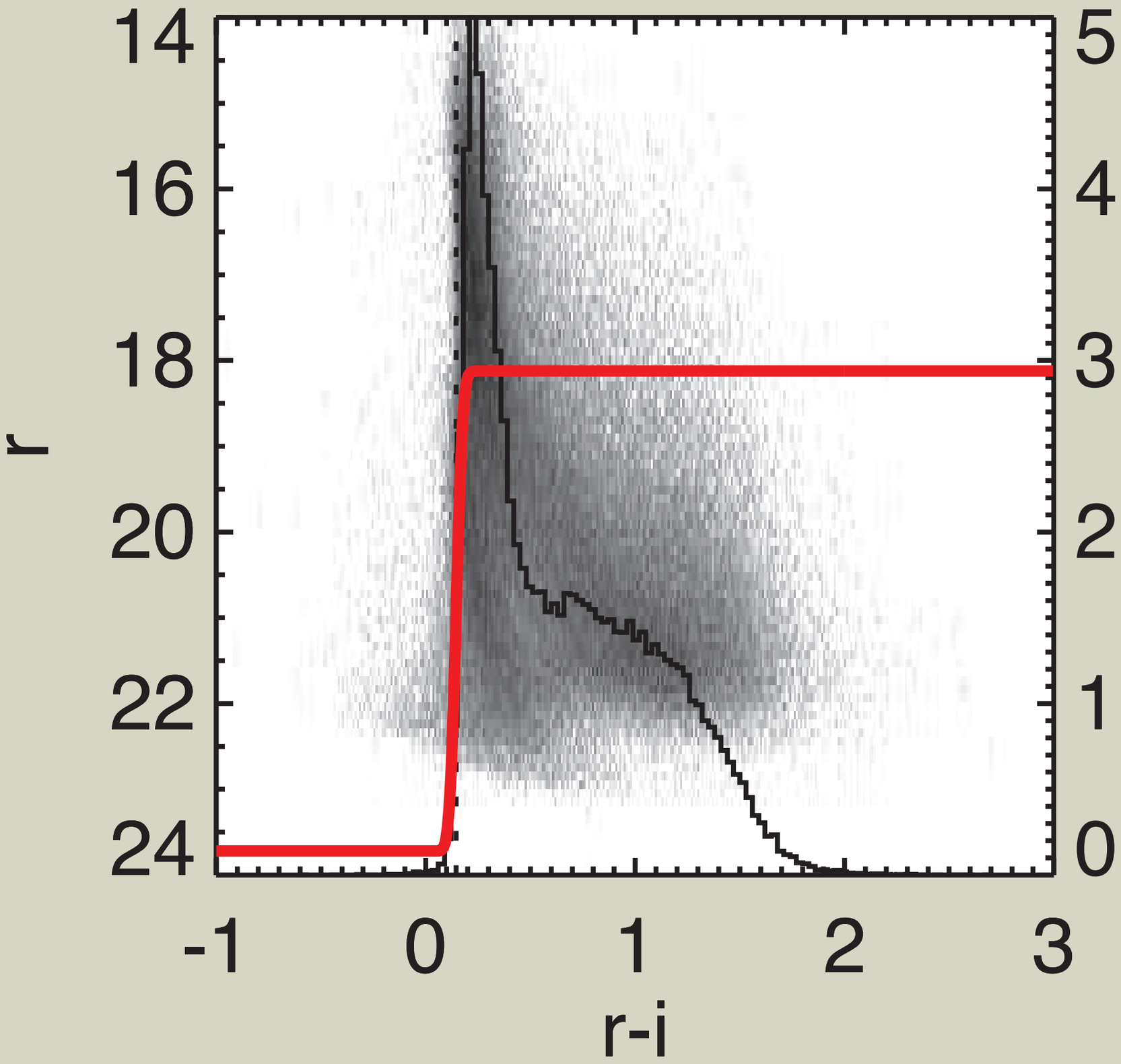
far

Standard Crayon:

clear

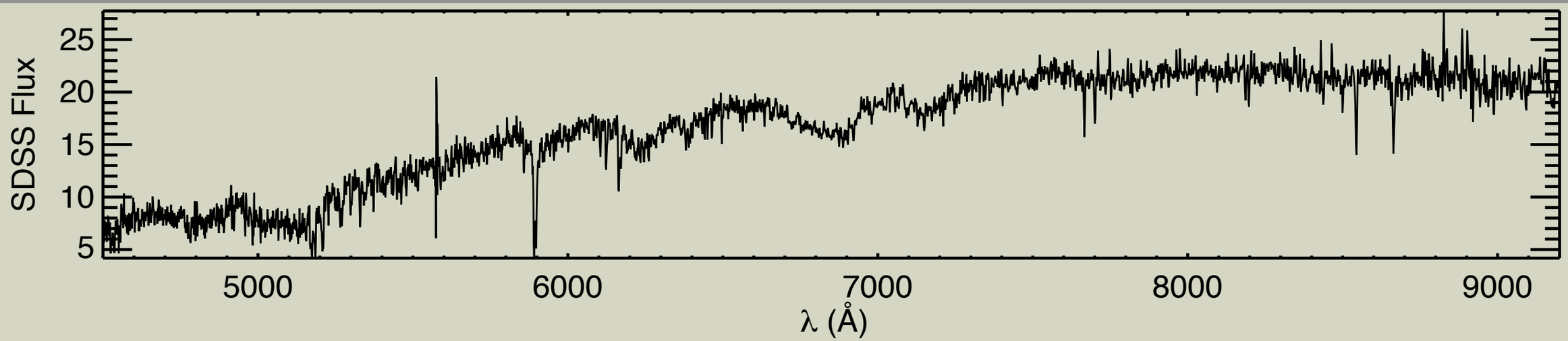
obscured

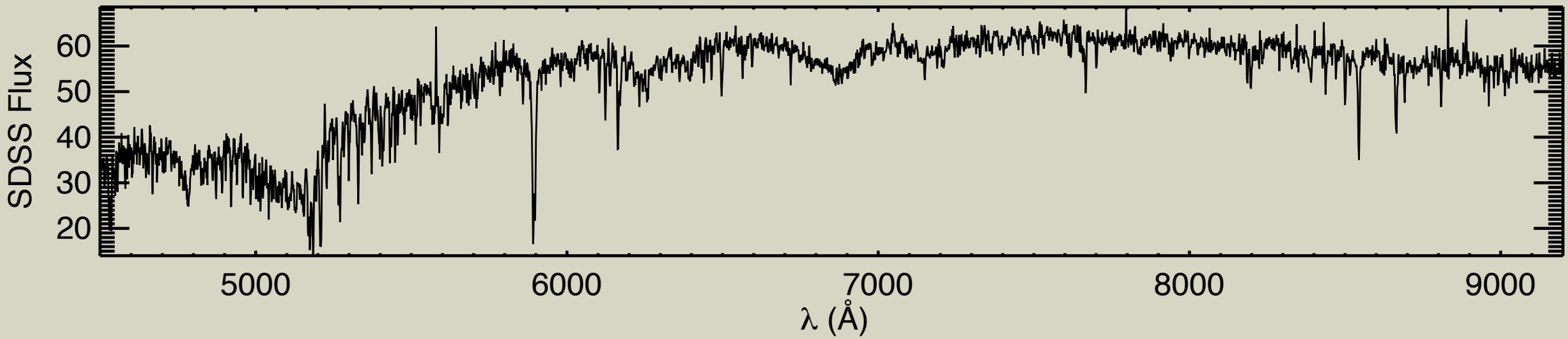
The blue end of the stellar locus reveals reddening.

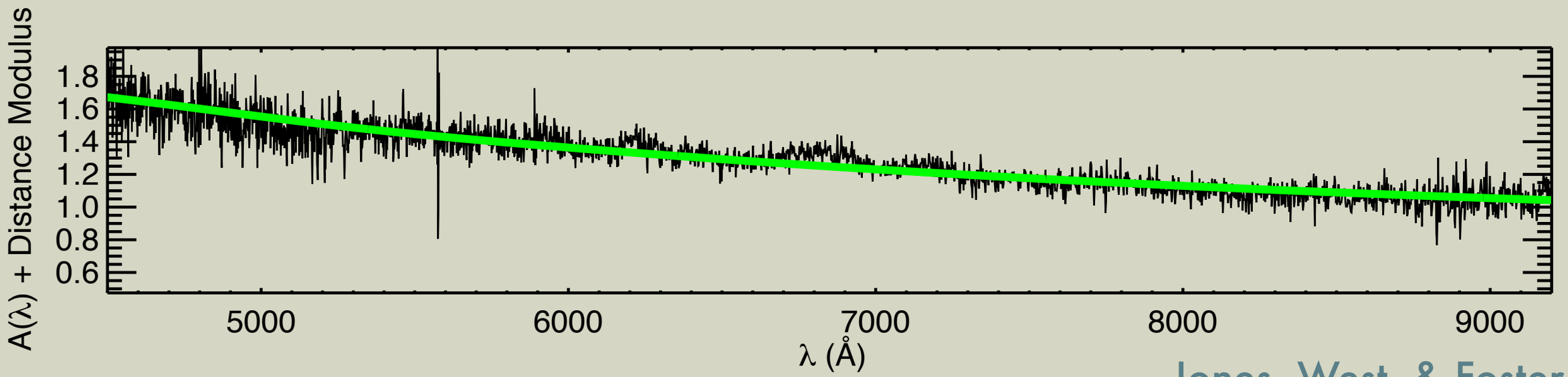


Schlafly+ 10

Stellar spectra can also be used to find reddening.

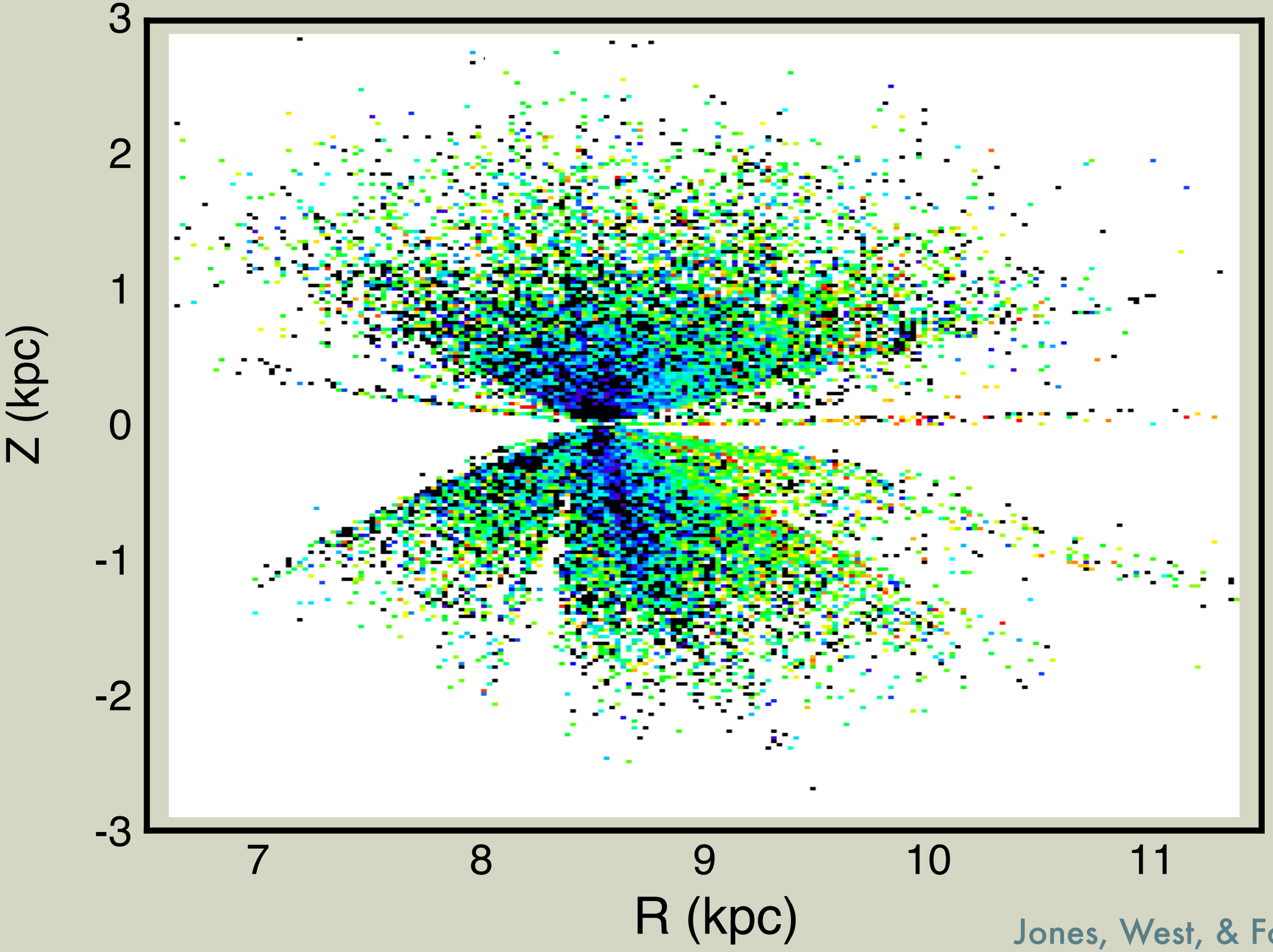






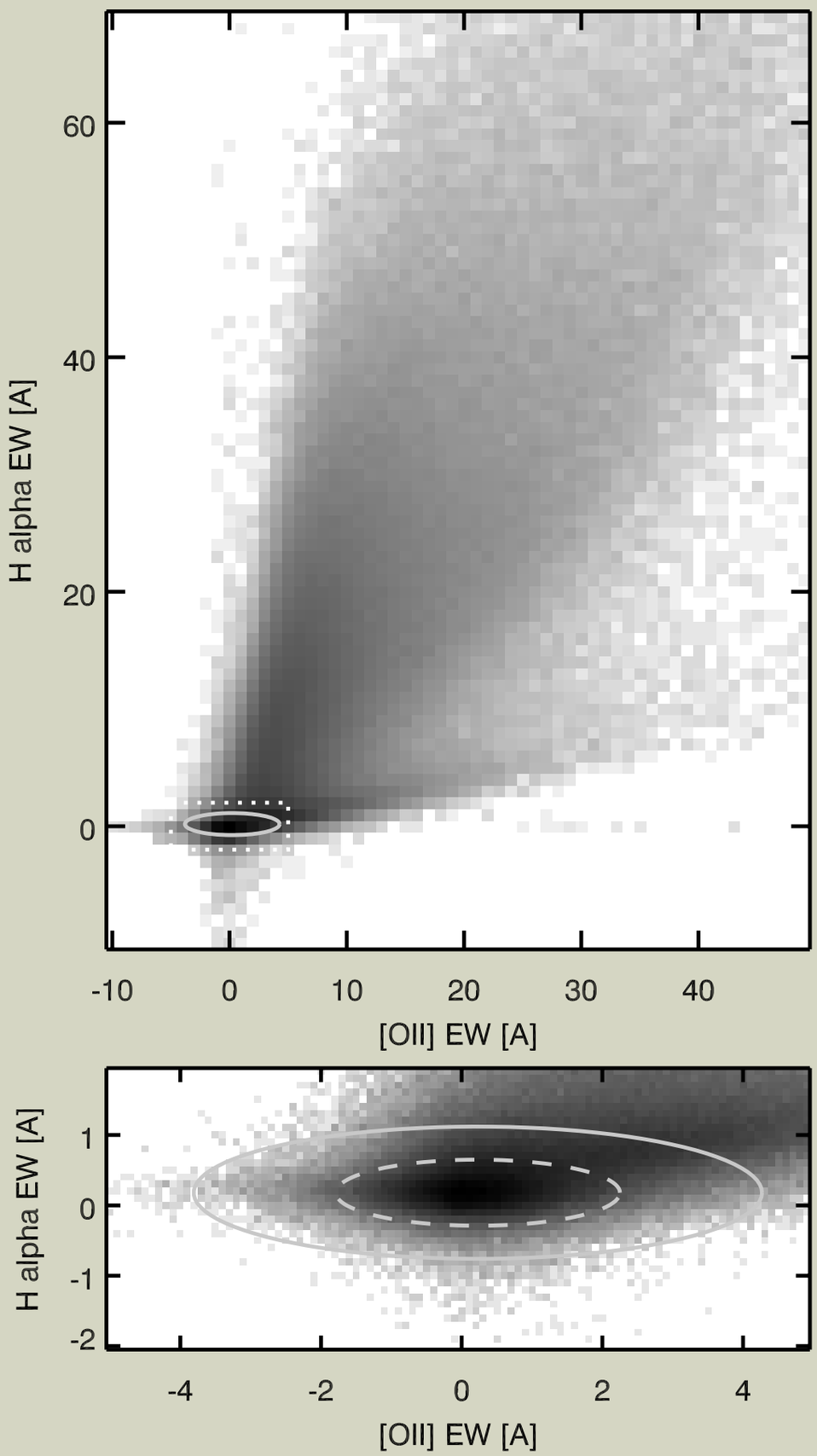
Jones, West, & Foster 11

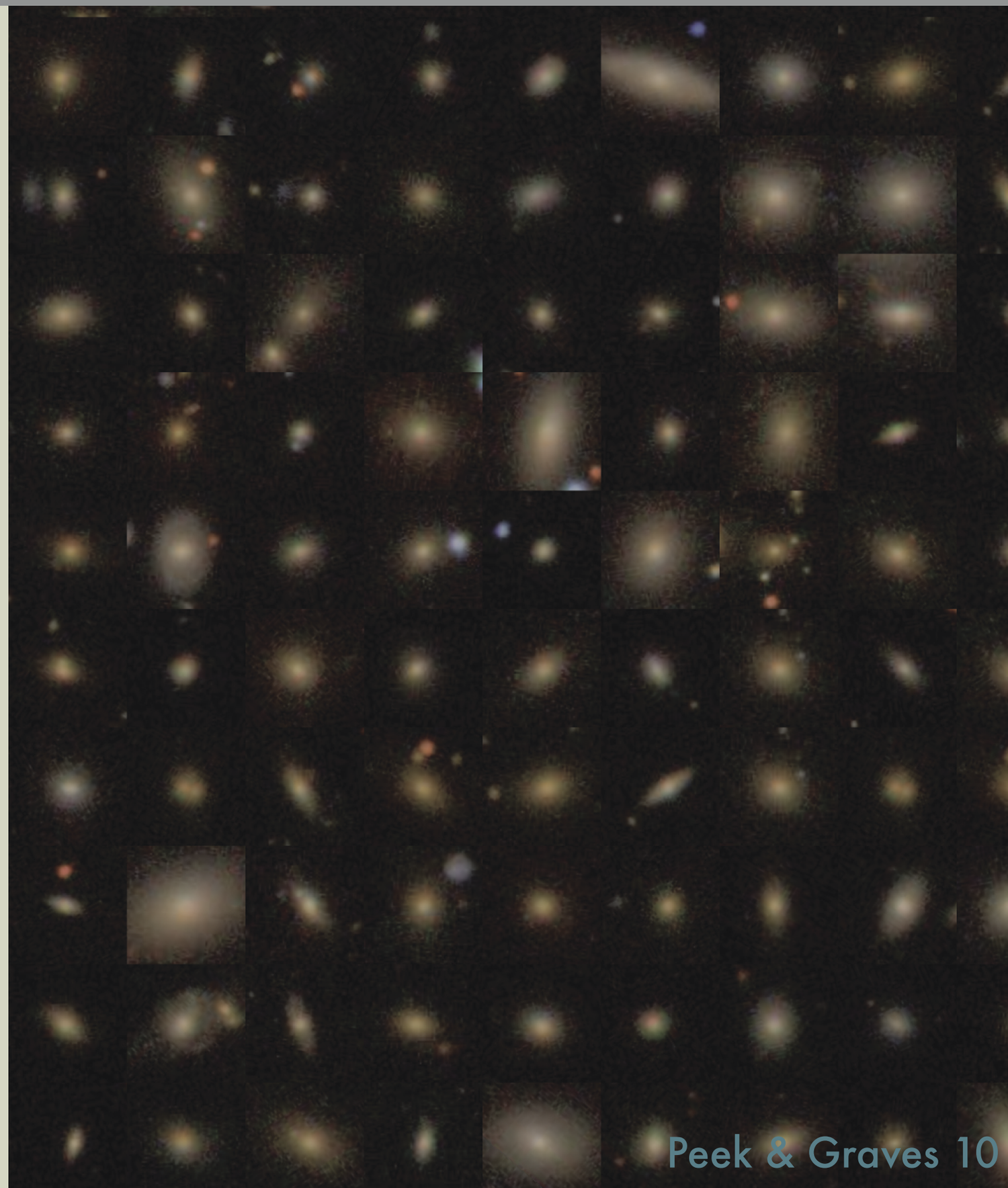
We can map our galaxy with dust measurements.



Jones, West, & Foster 11

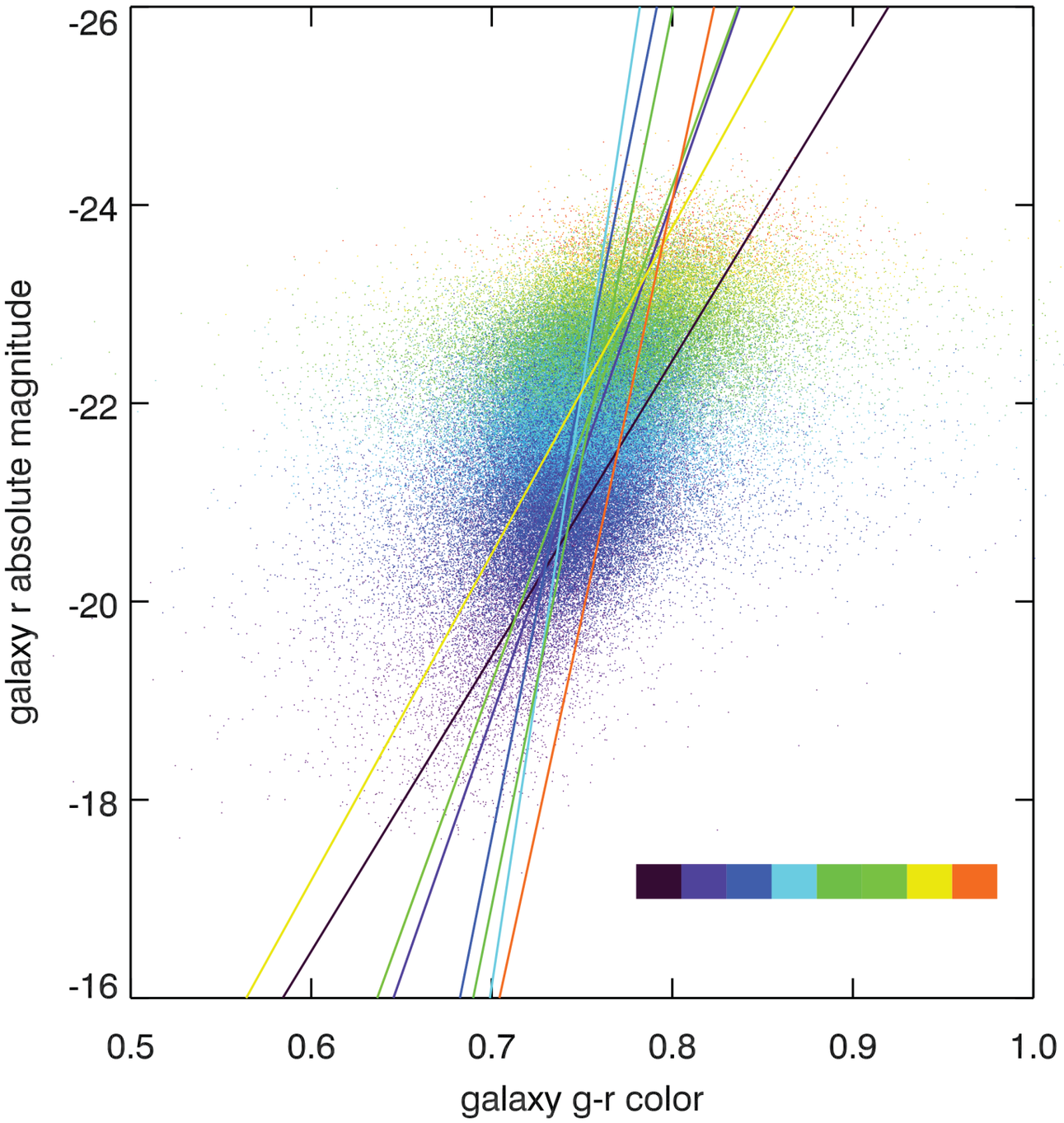
Quiescent galaxies can be selected spectroscopically.

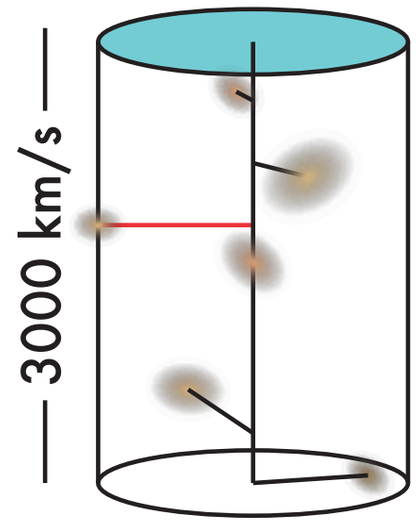




Peek & Graves 10

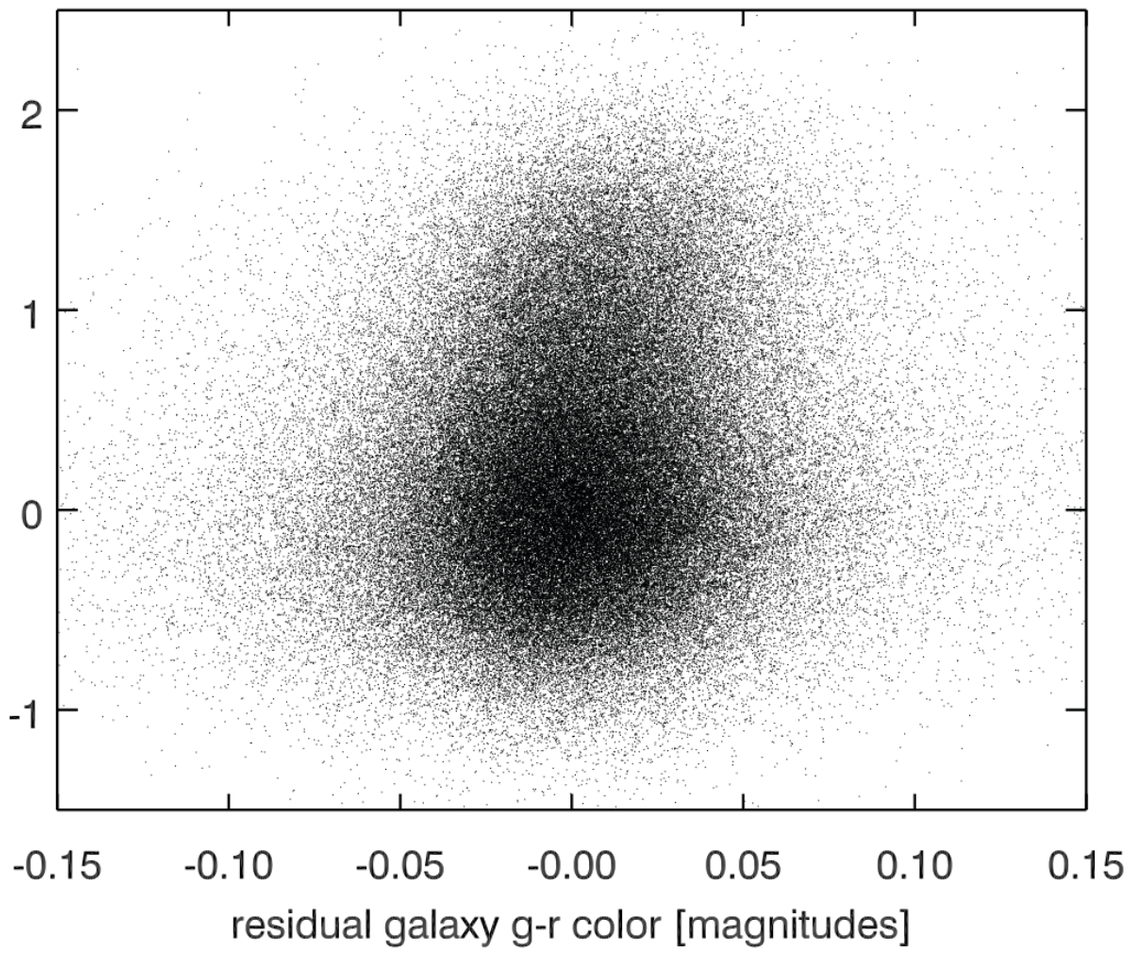
Our galaxies have color trends with abs. mag. and density.



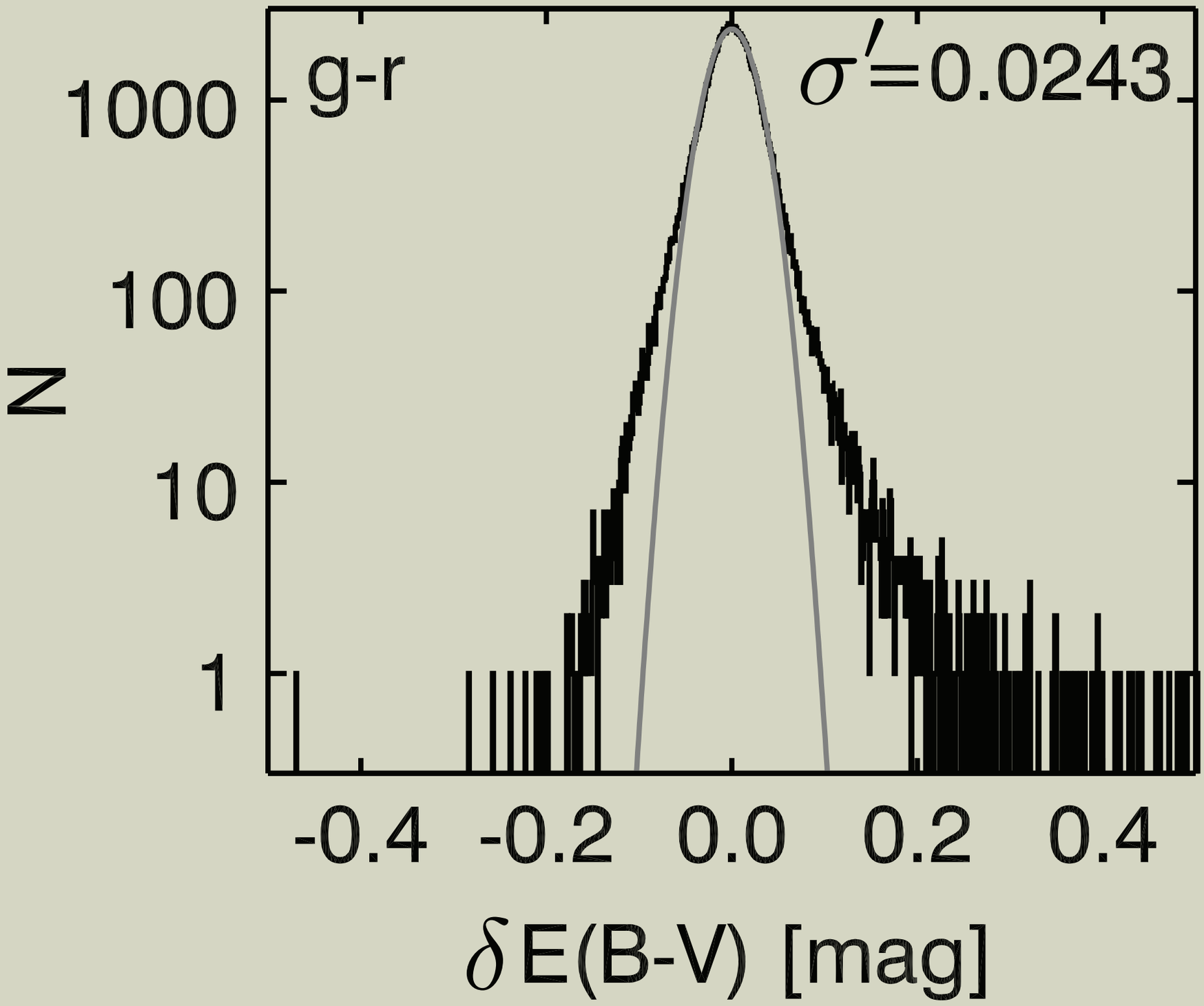


$$\Sigma_5 = 5/A_5$$

$$\delta_5 = \frac{\Sigma_5}{\langle \Sigma_5 \rangle_z} - 1$$

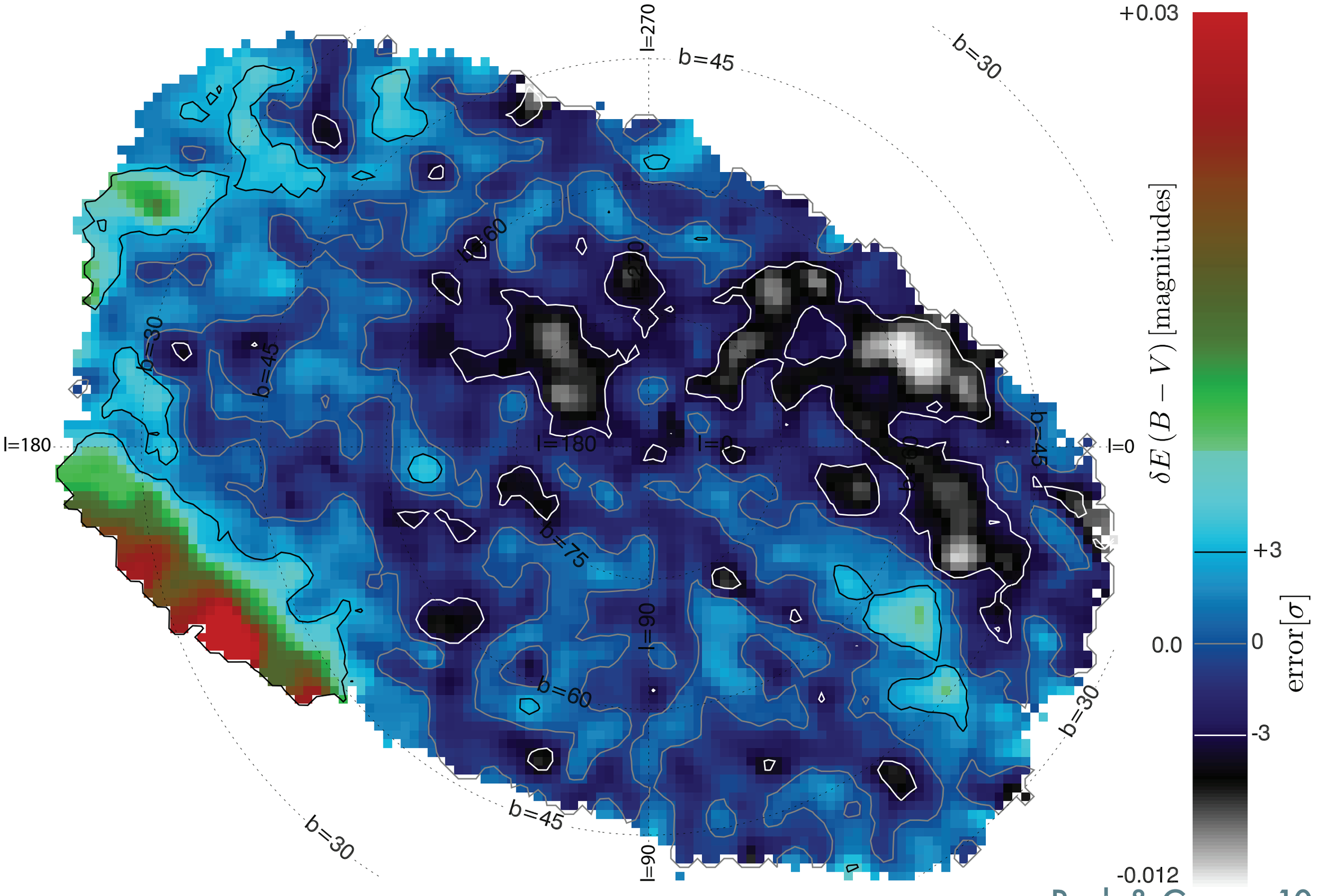


Residual colors are very, very small.



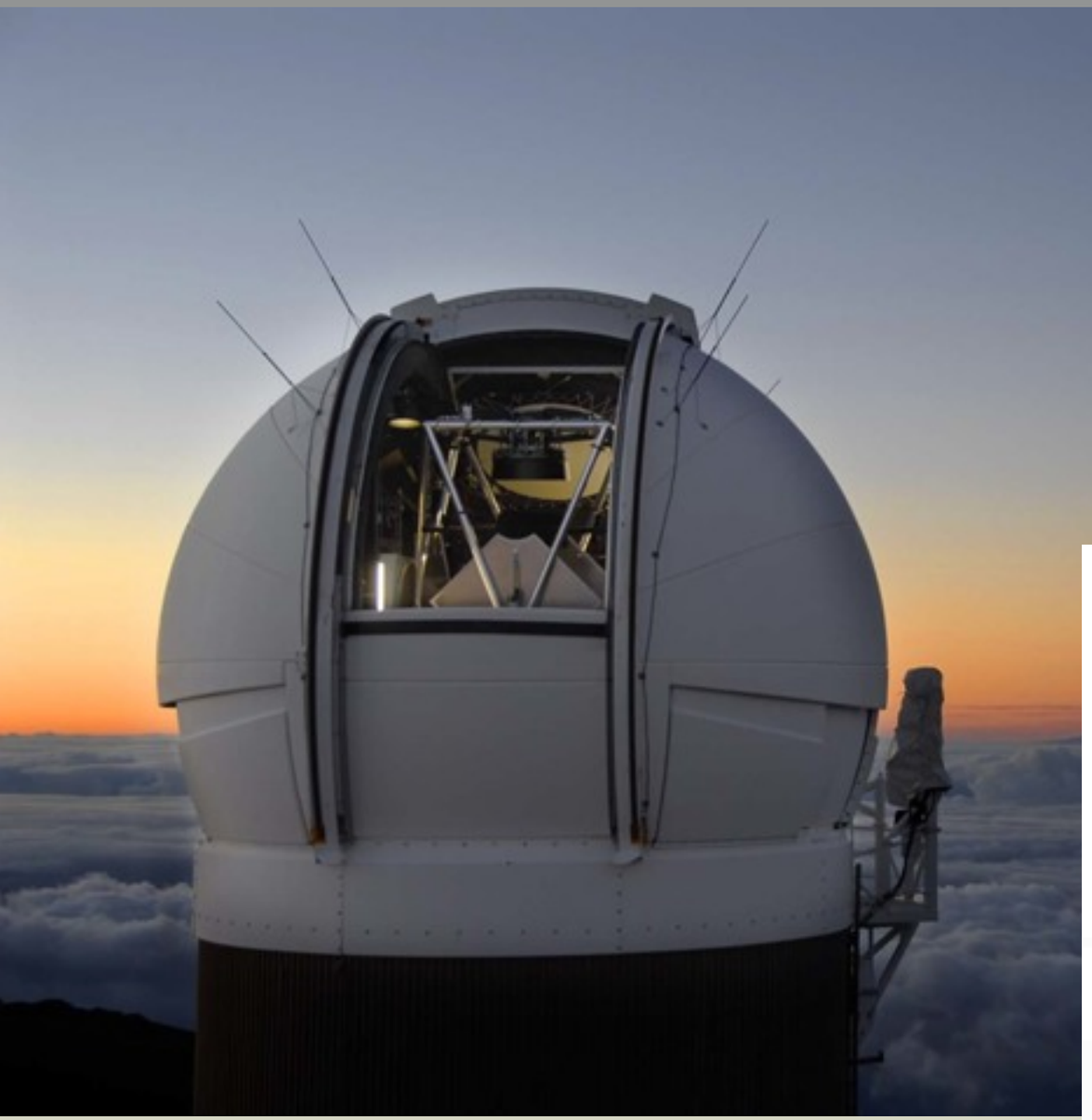
Peek & Graves 10

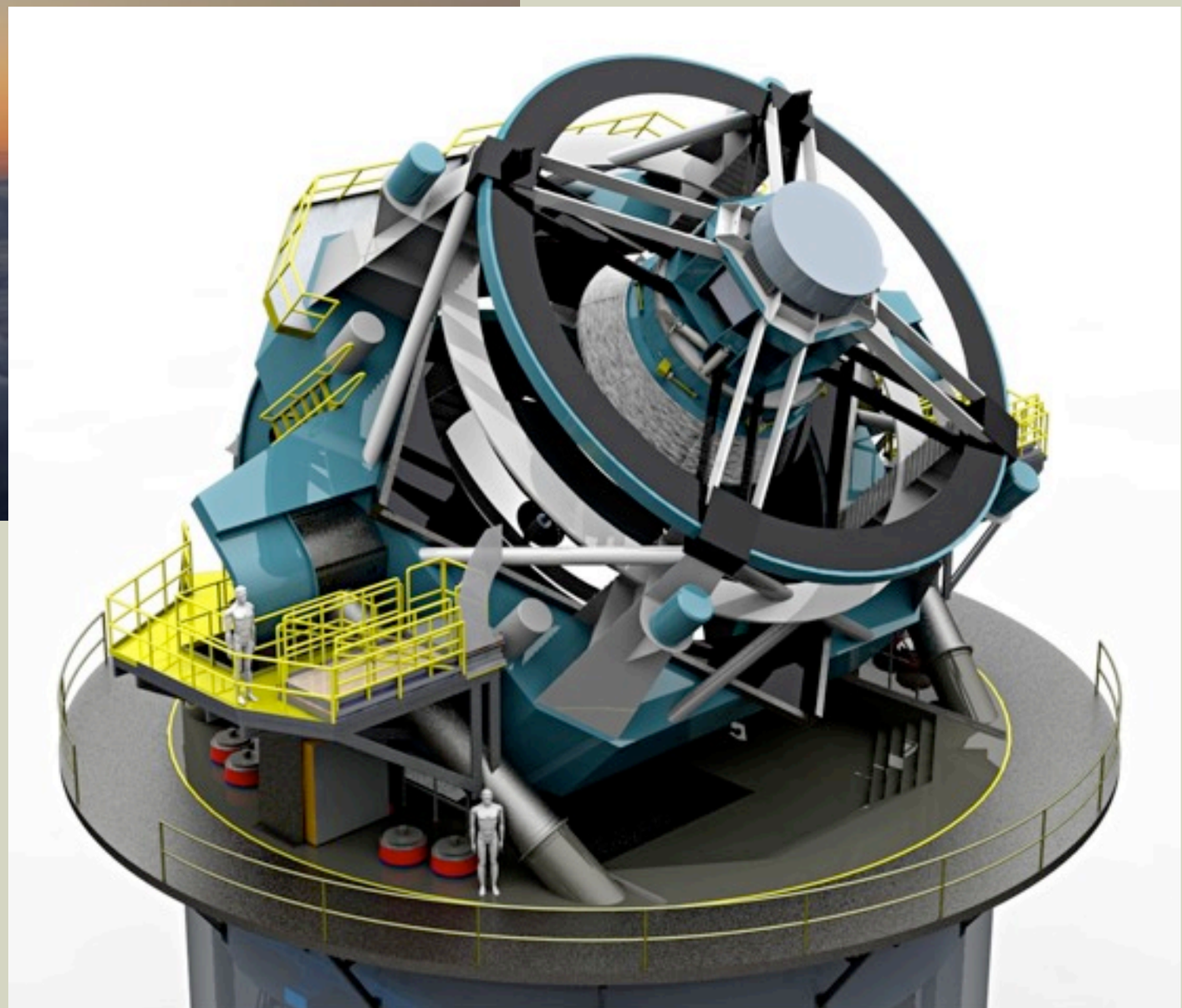
We have corrections to the SFD98 reddening map.



Peek & Graves 10

Vast quantities of industrial photometry are coming...





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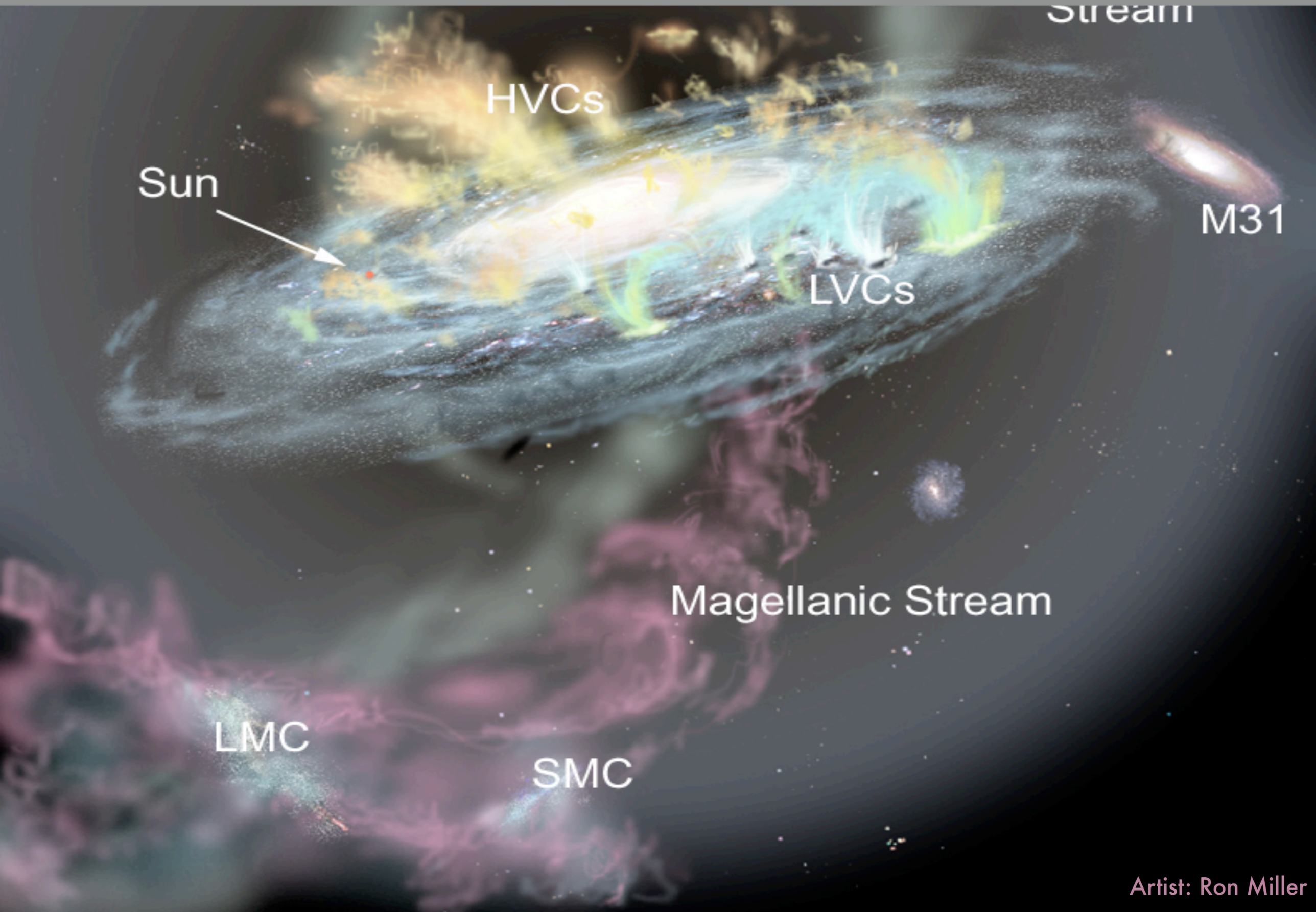
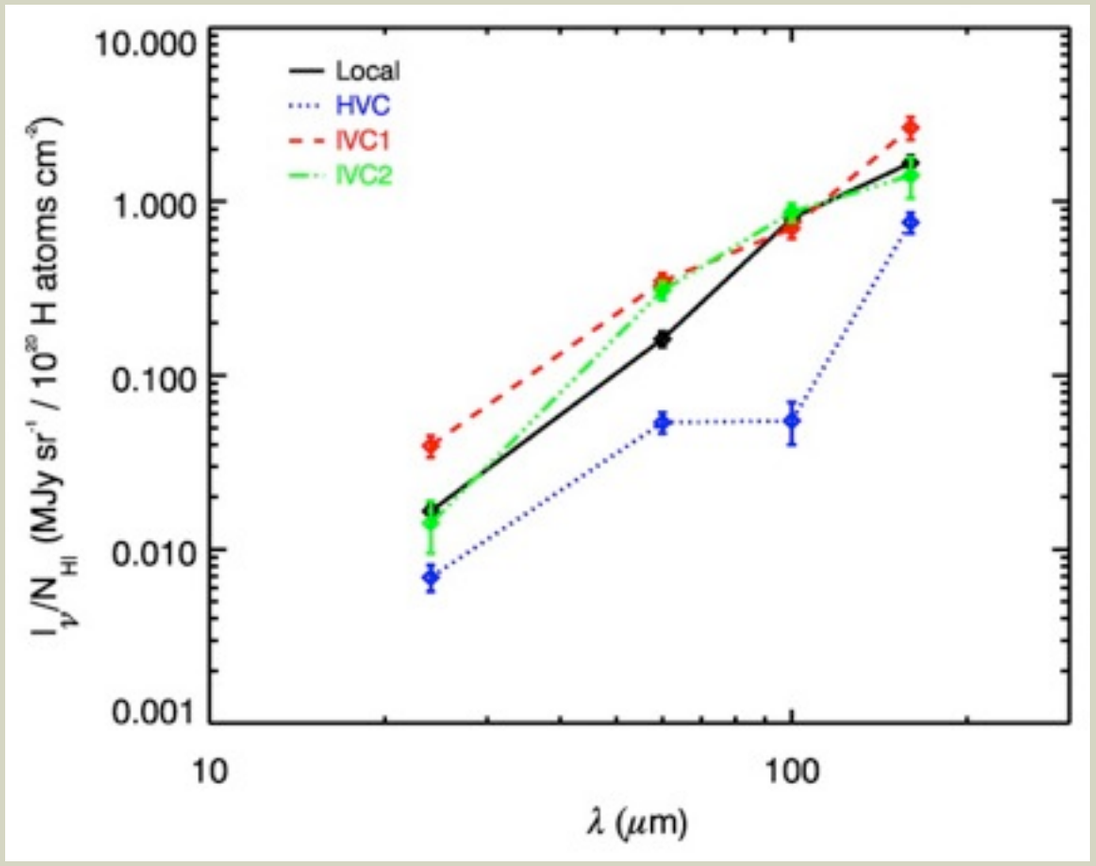
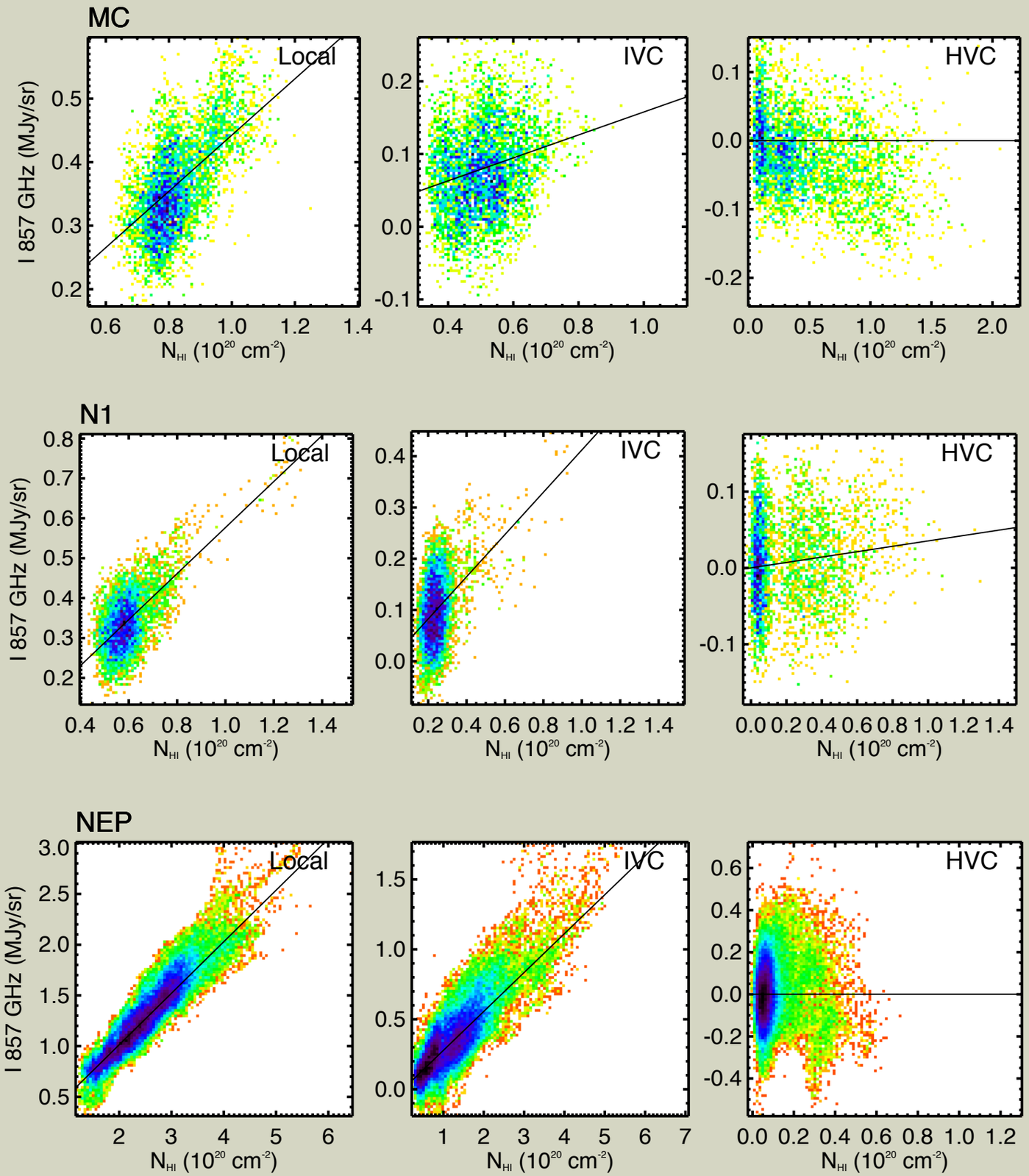
HVCs dust properties constrain feedback and origins.

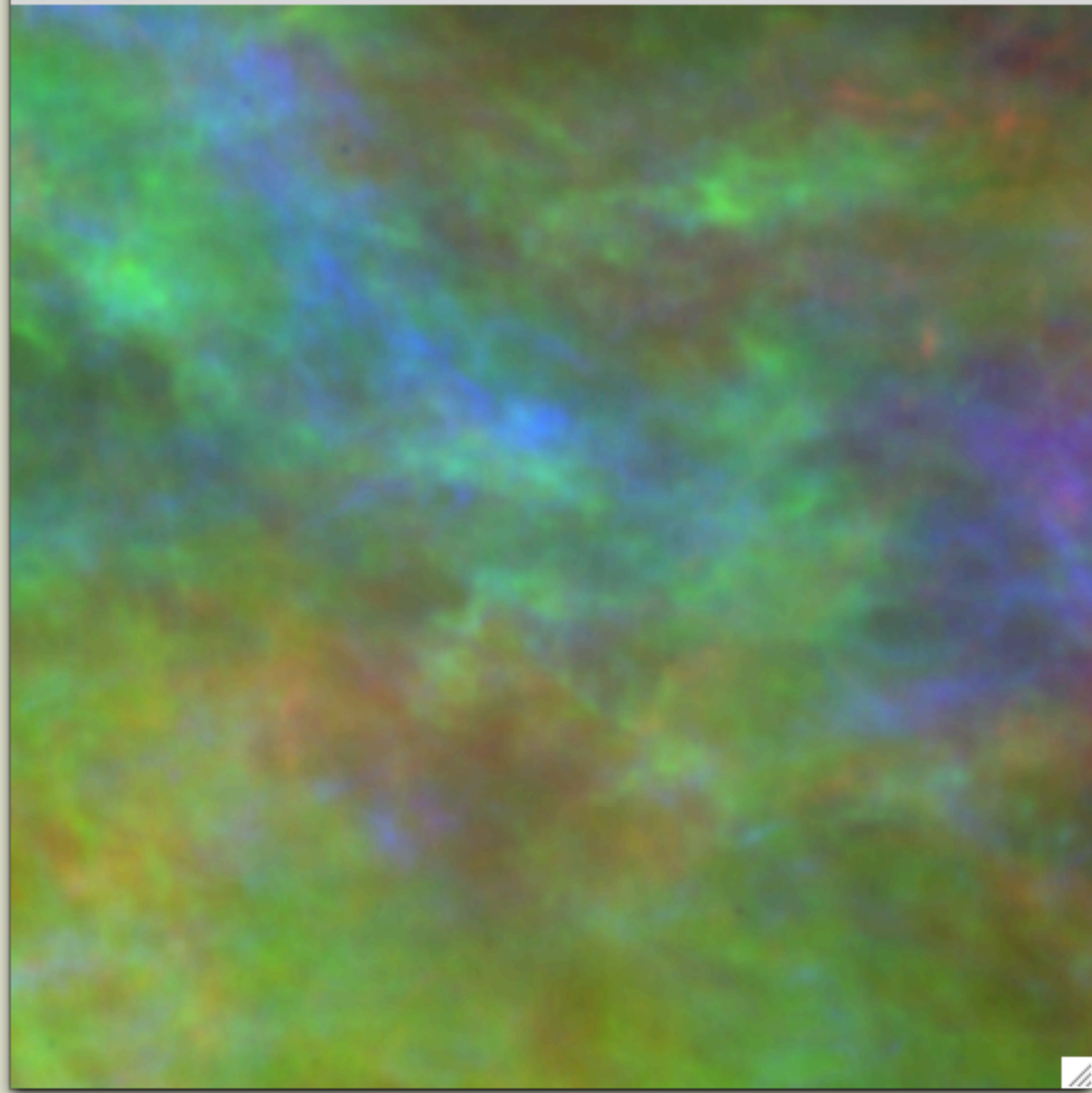


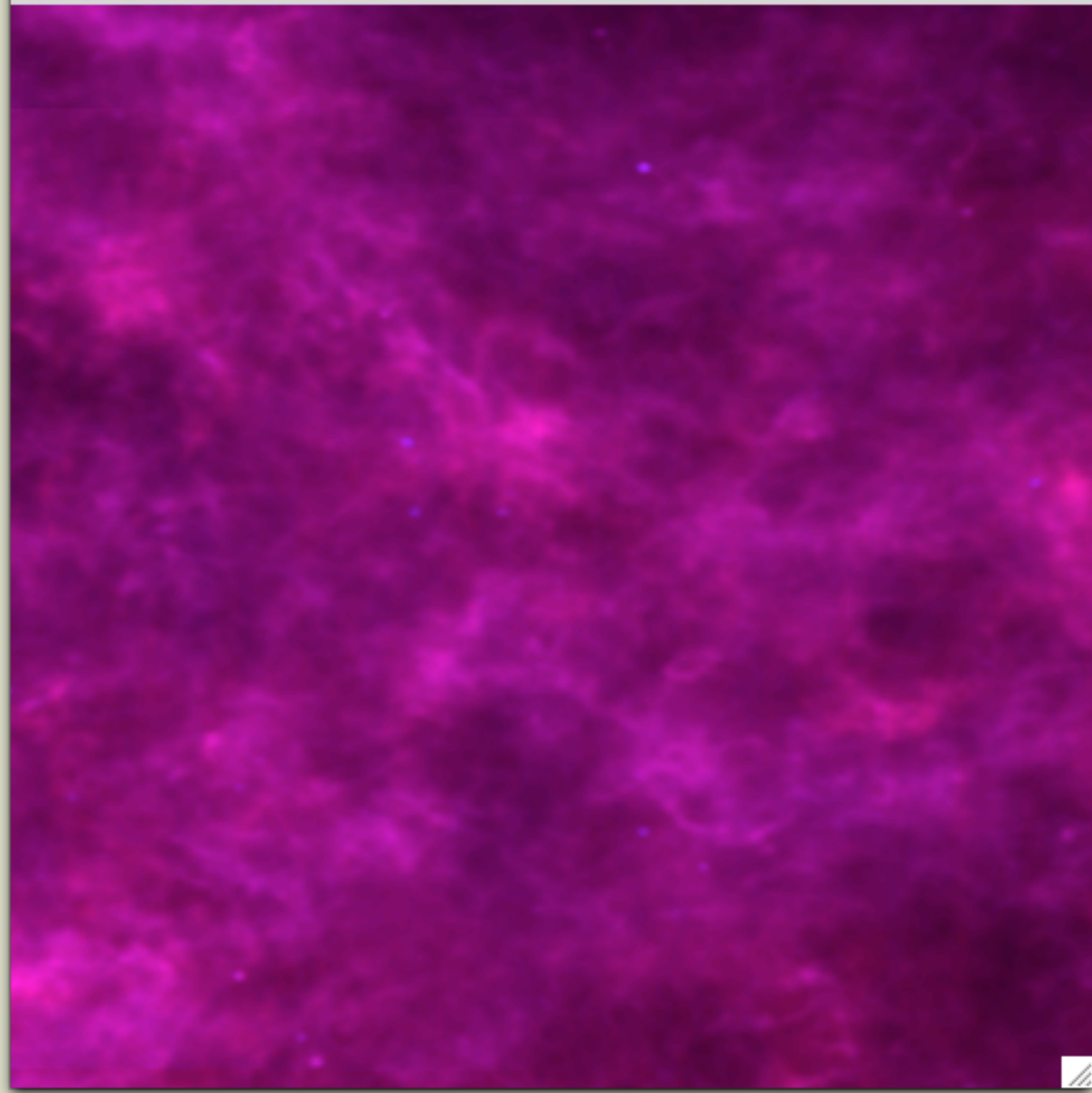
HVCs have extremely little (if any) far IR dust emission.



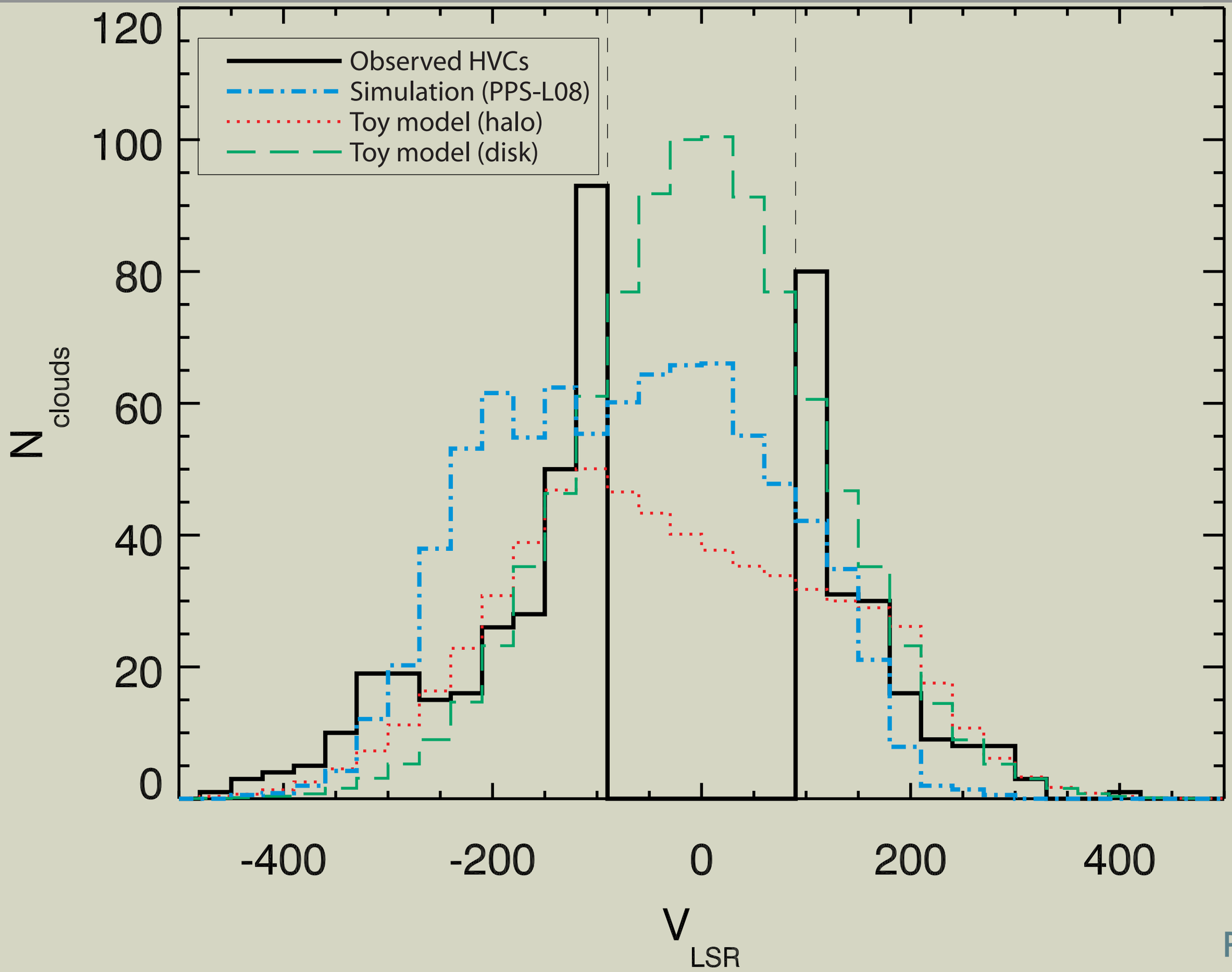


Miville-Deschenes+ 05, Planck Collaboration 11





Low-velocity halo clouds can be found through low dust.



Peek+ 09

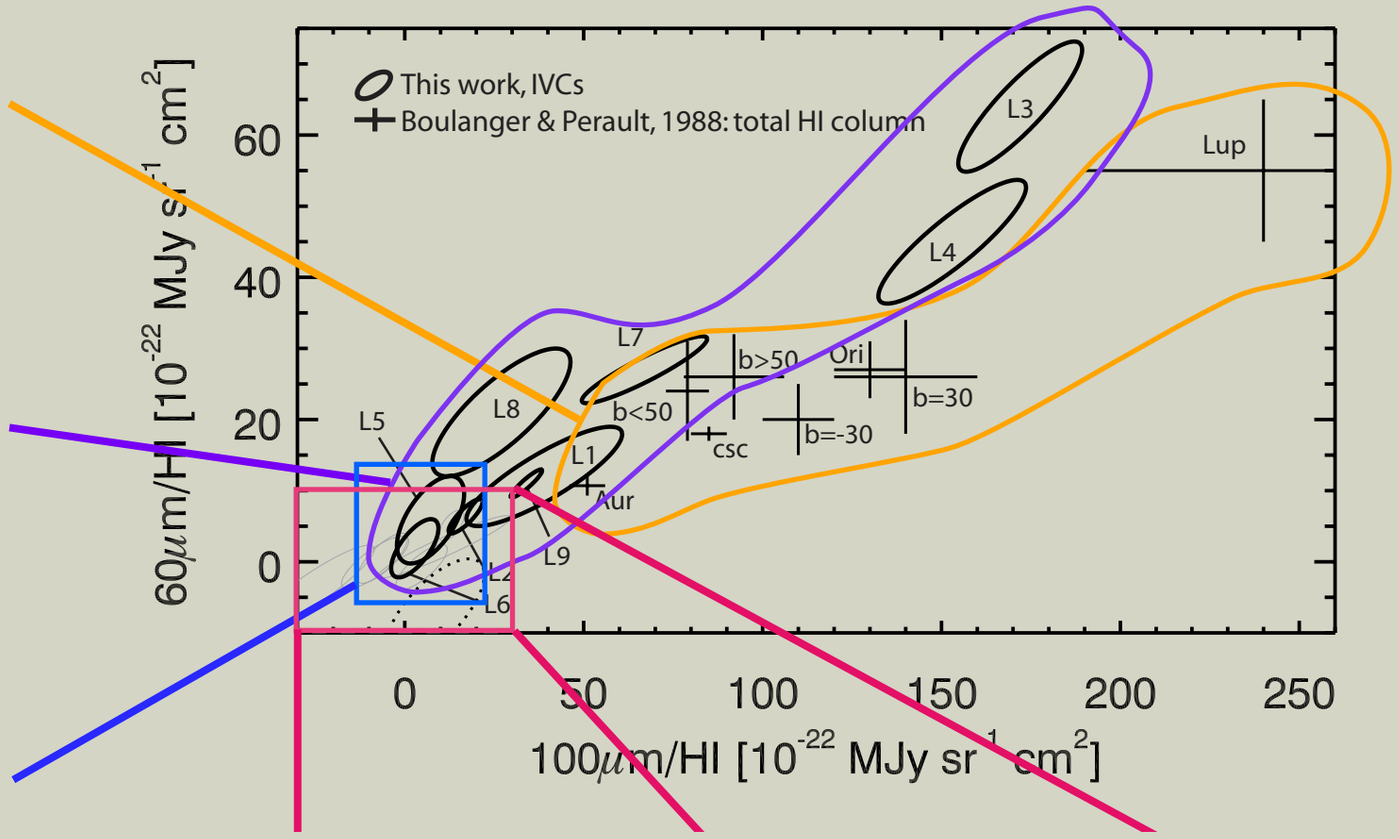
Dust to gas ratios for typical Galactic regions

IVCs tend to have hotter dust grains than standard Galactic dust

Two observed IVCs have no detectable dust: LVHC candidates

Most observed HVCs have no appreciable dust, as expected

Complex M may indeed have a small amount of dust emission



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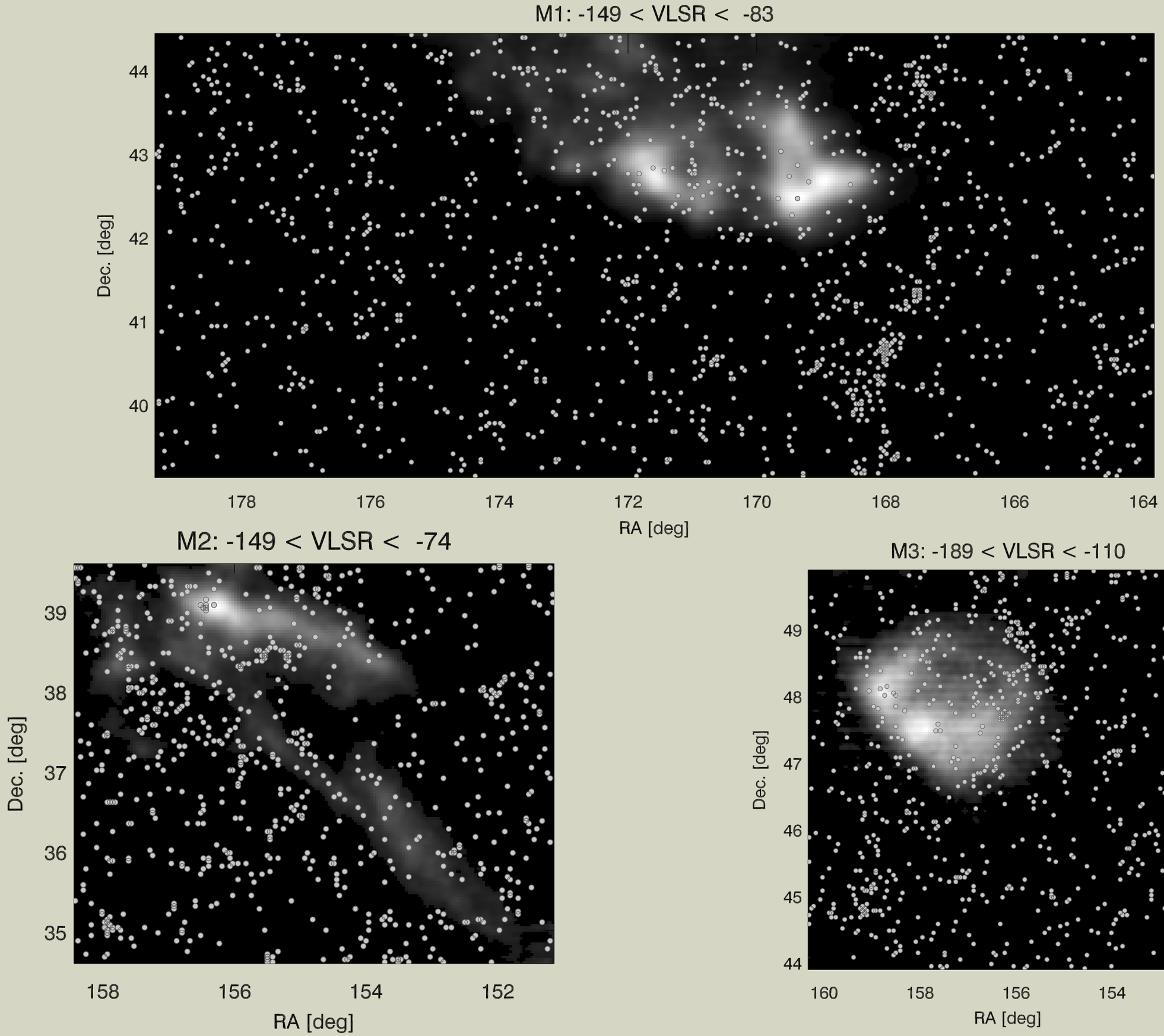
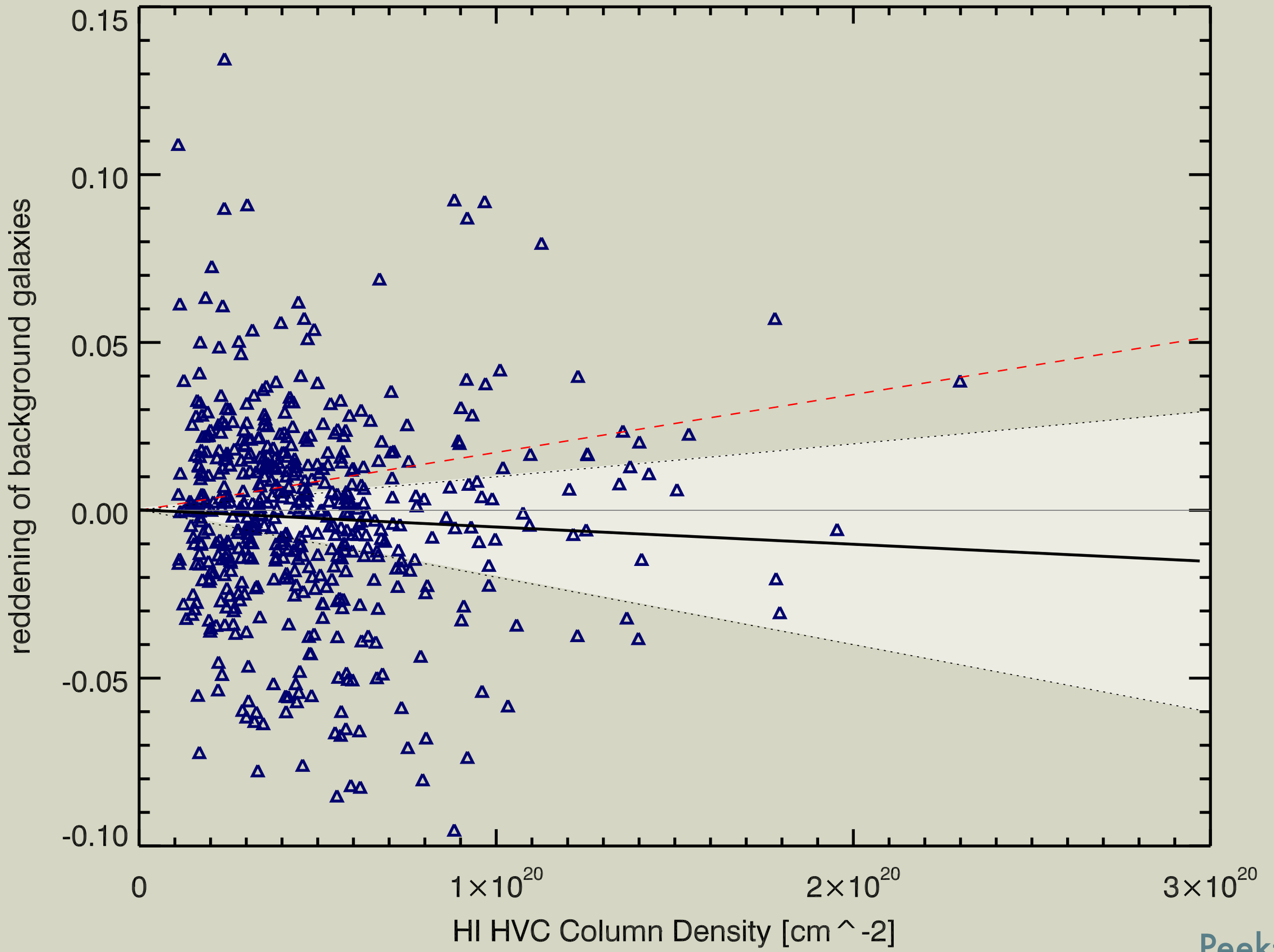
EBHIS + quiescent galaxies trace HVC dust in absorption.



Peek+ 12a

Complex M has no associated reddening!



Peek+ 12a

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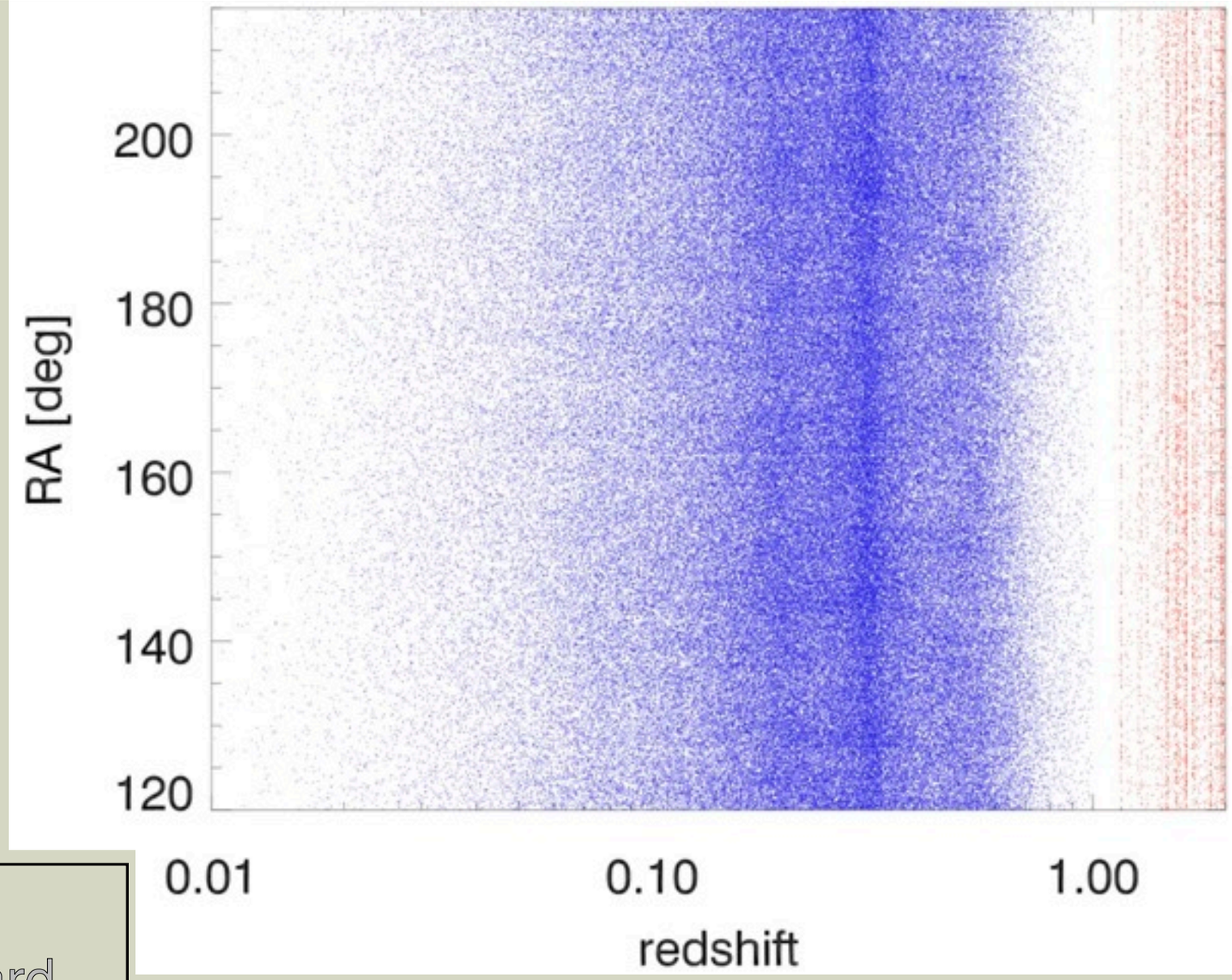
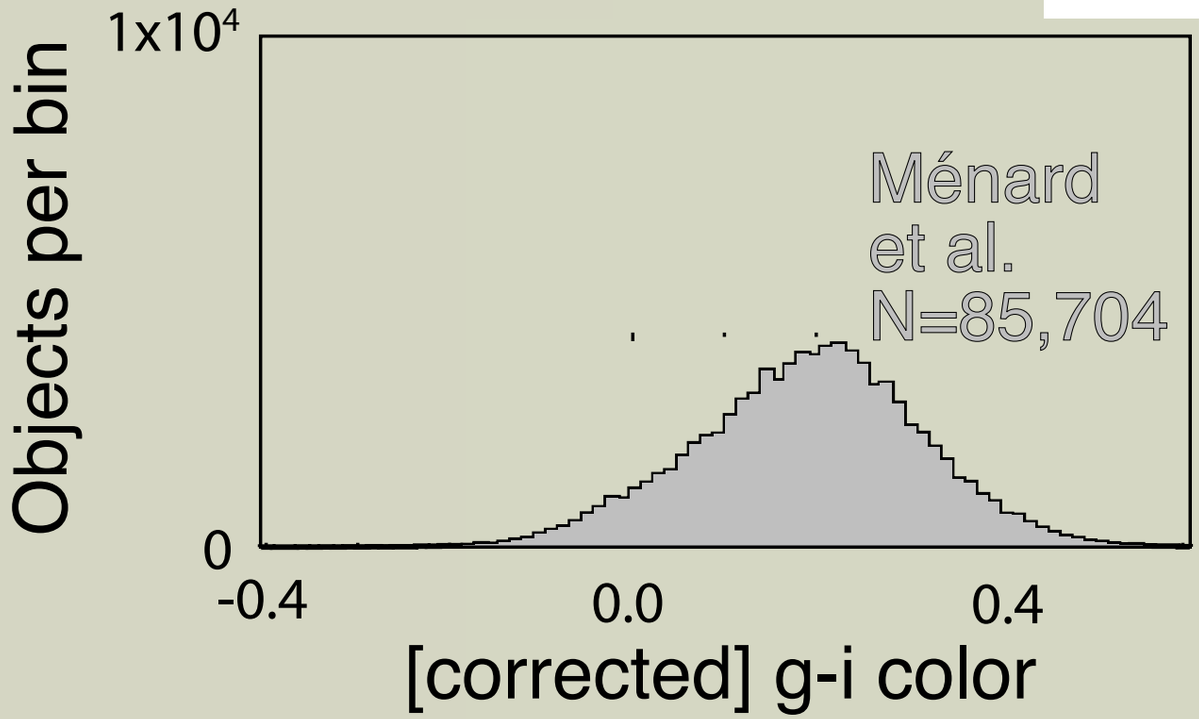
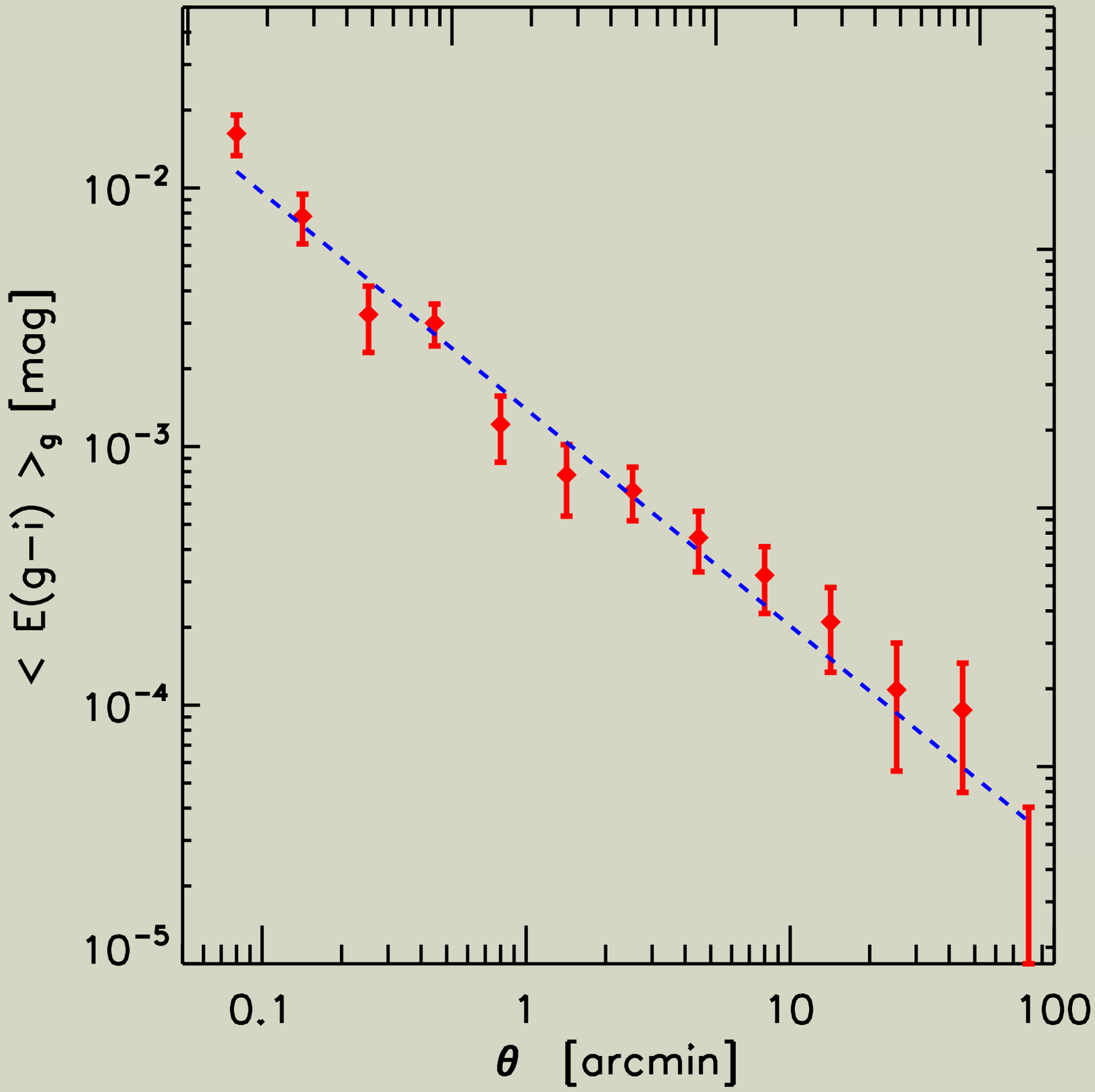
Quasar color near SDSS galaxies trace extragalactic dust.





Ménard+ 10

Dust is found out to 10 Mpc from galaxies!



Ménard+ 10

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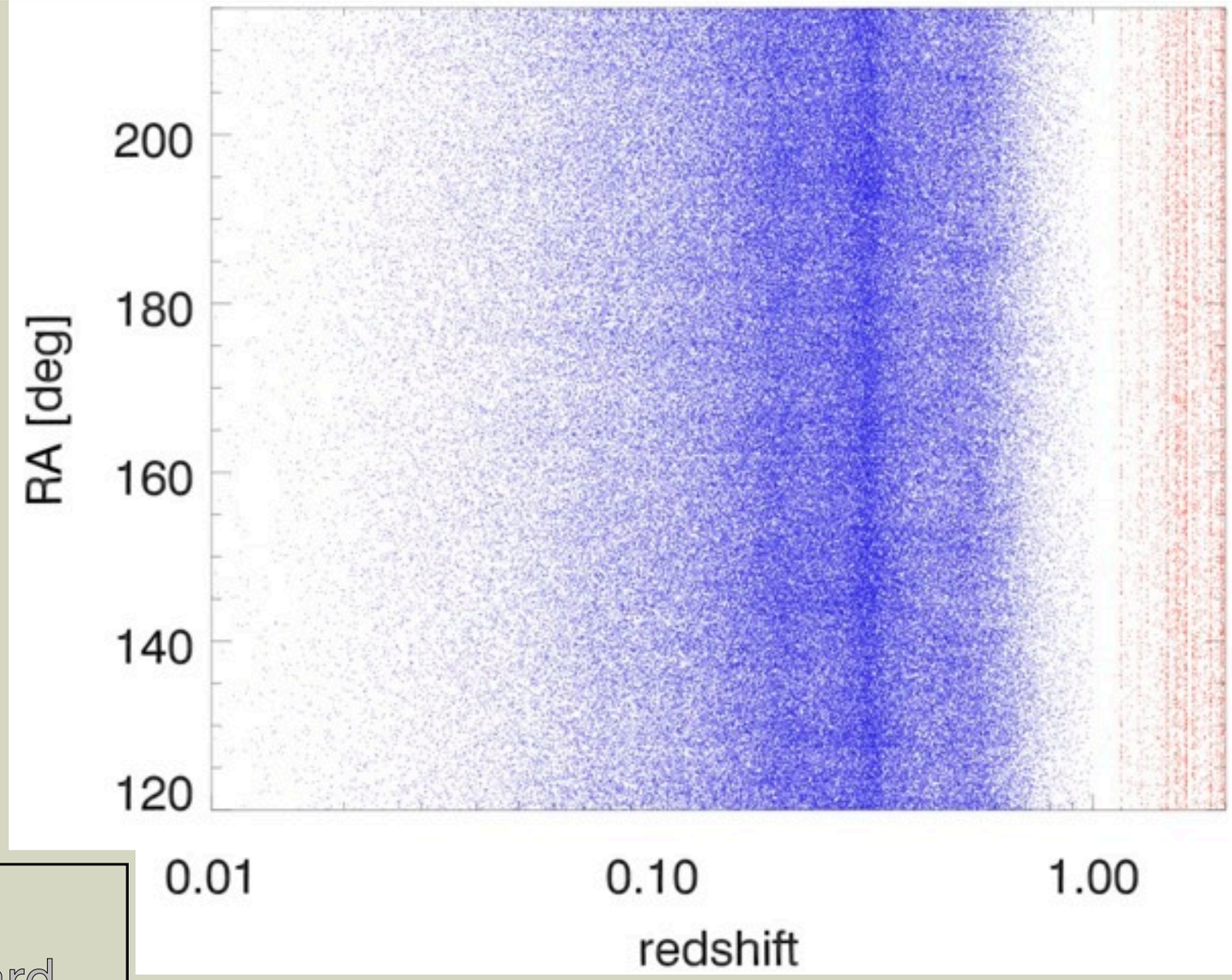
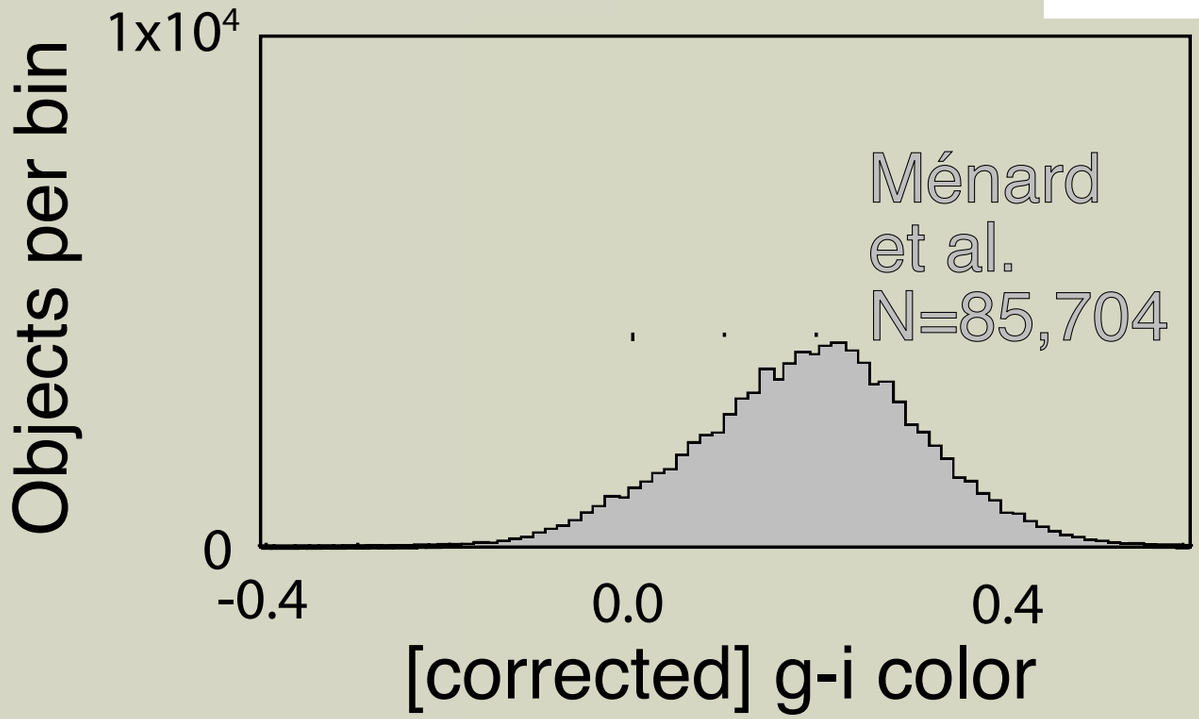
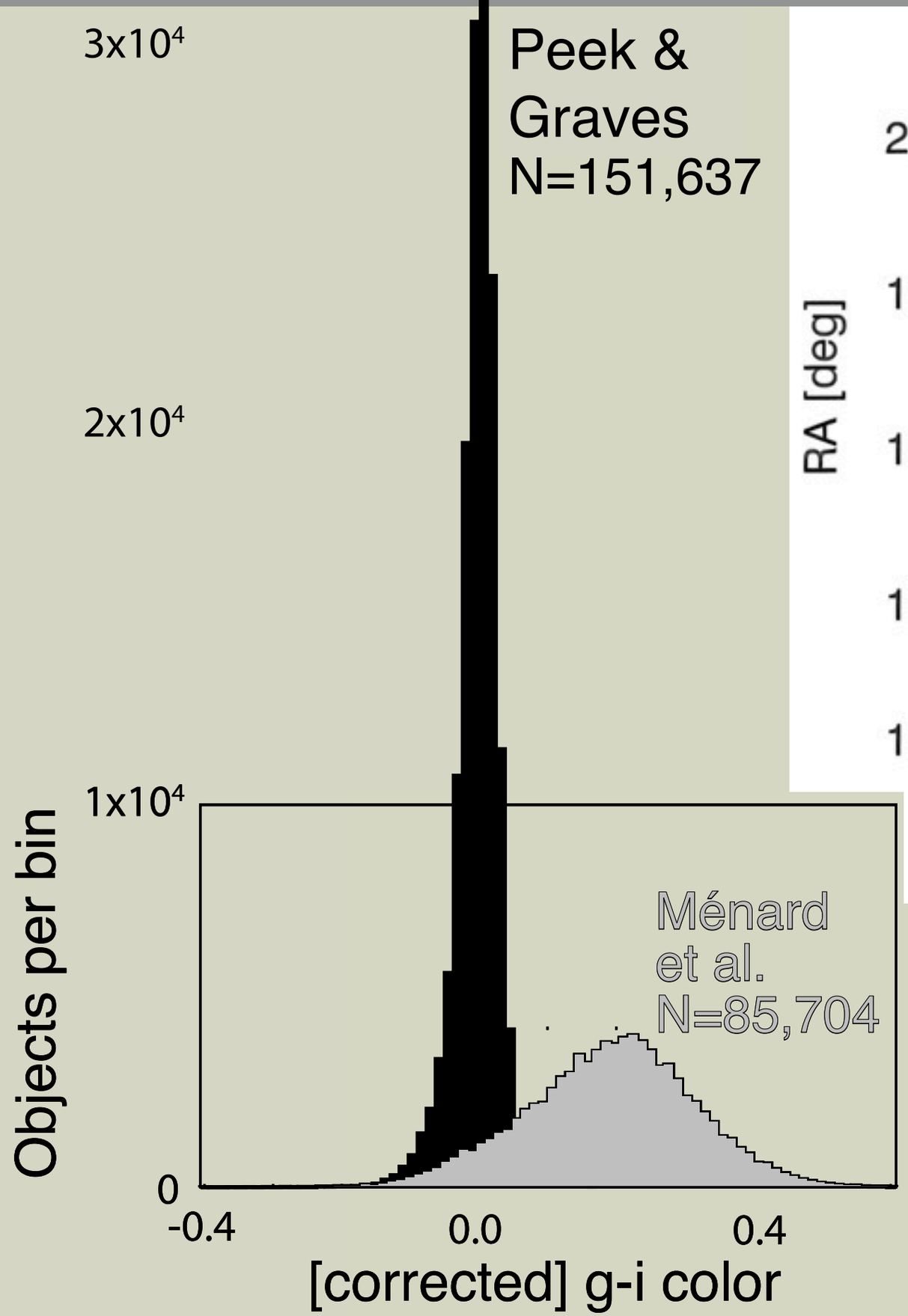
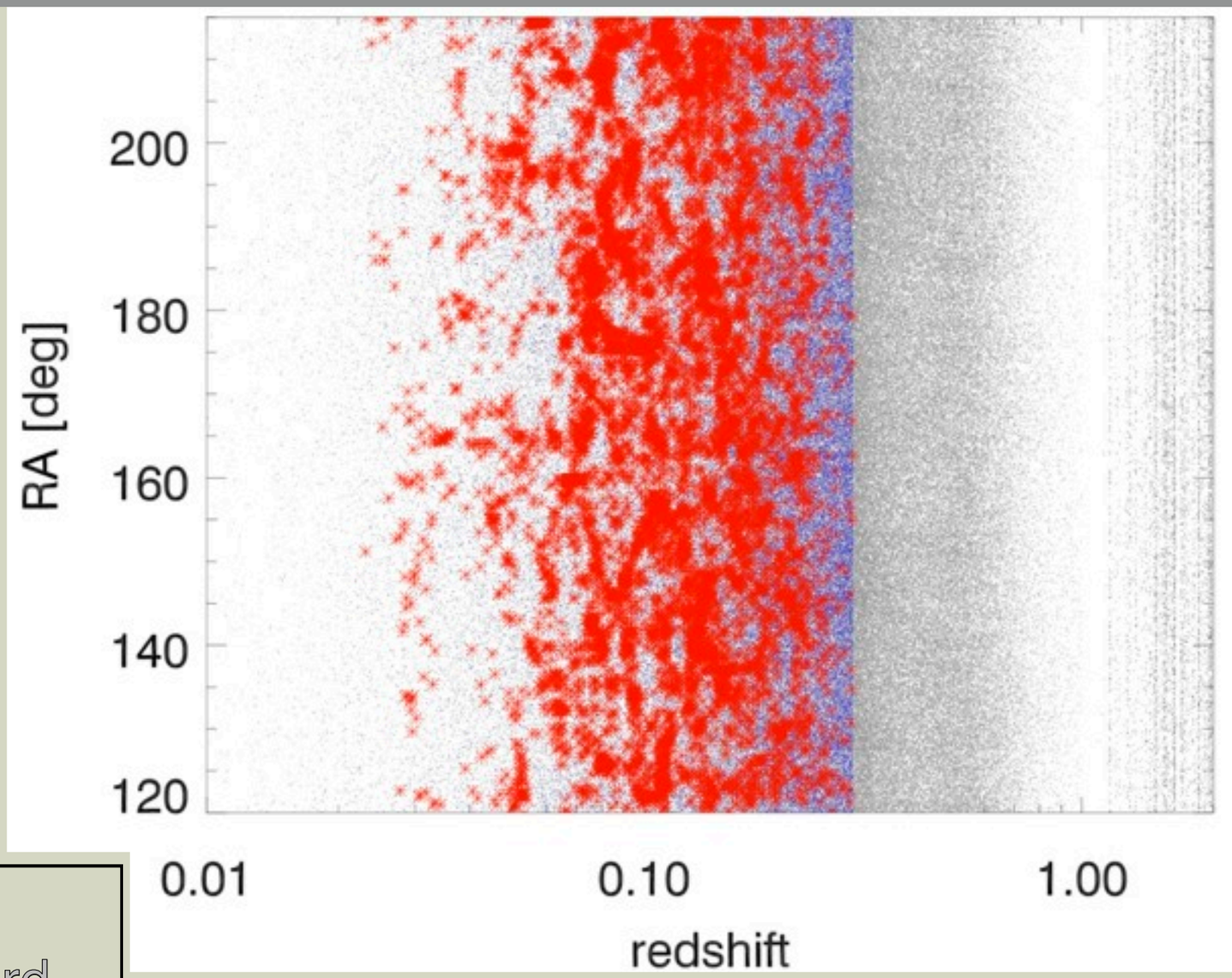




Ménard+ 10

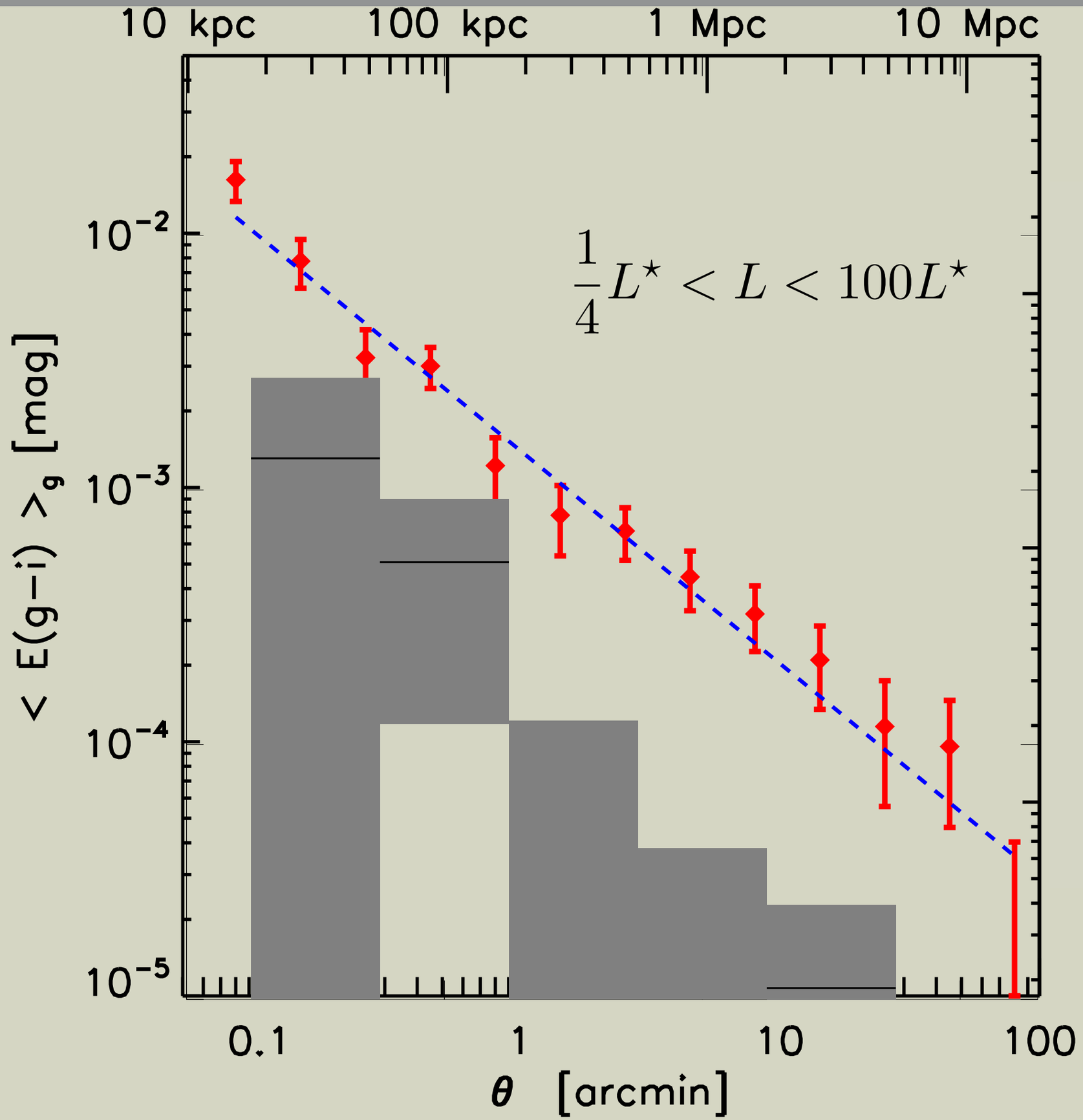
Quiescent galaxies: more precise; fewer foreground galaxies.





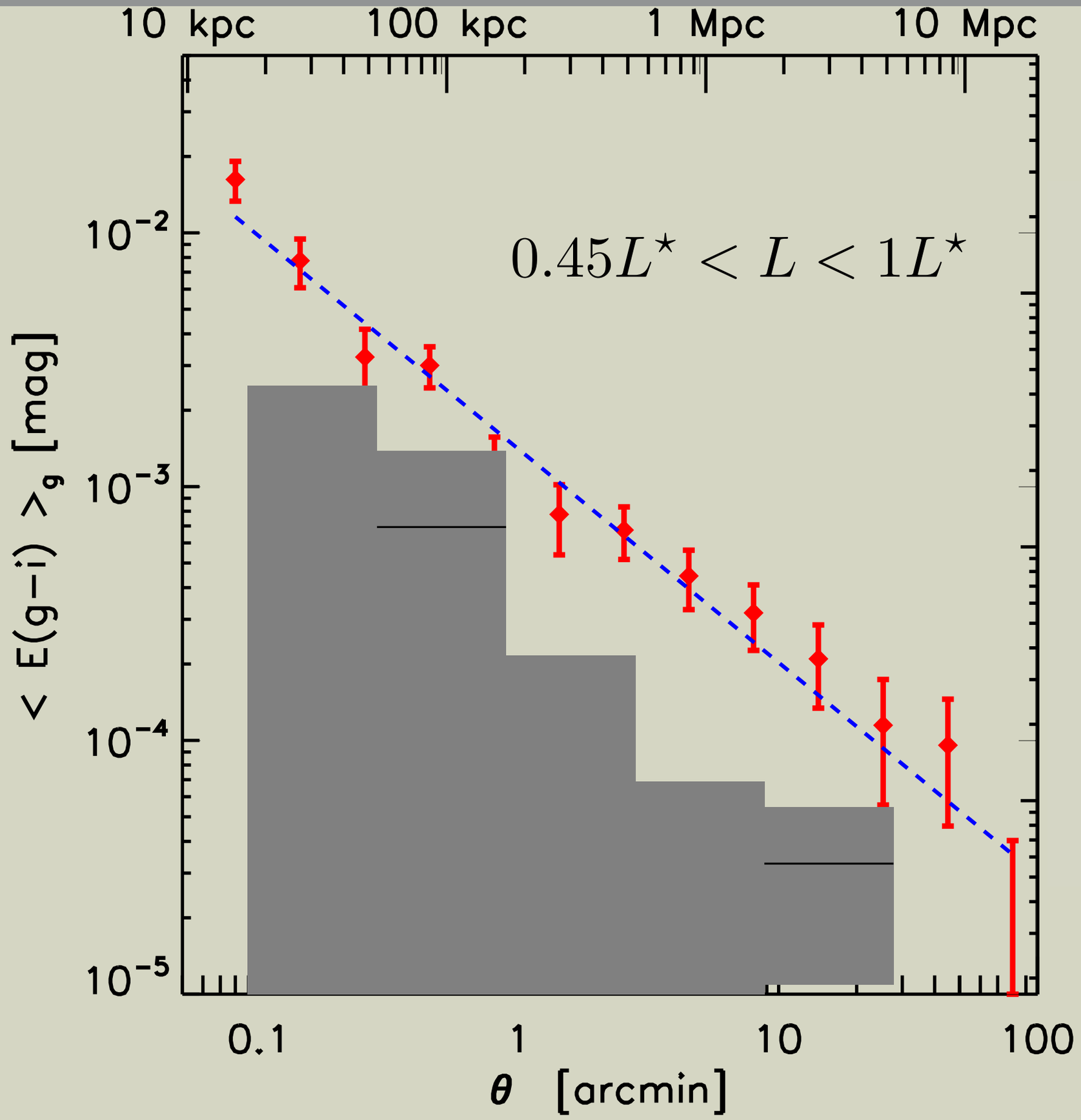
Ménard+ 10, Peek+ 12

Quiescent galaxies are inconsistent with quasar results.



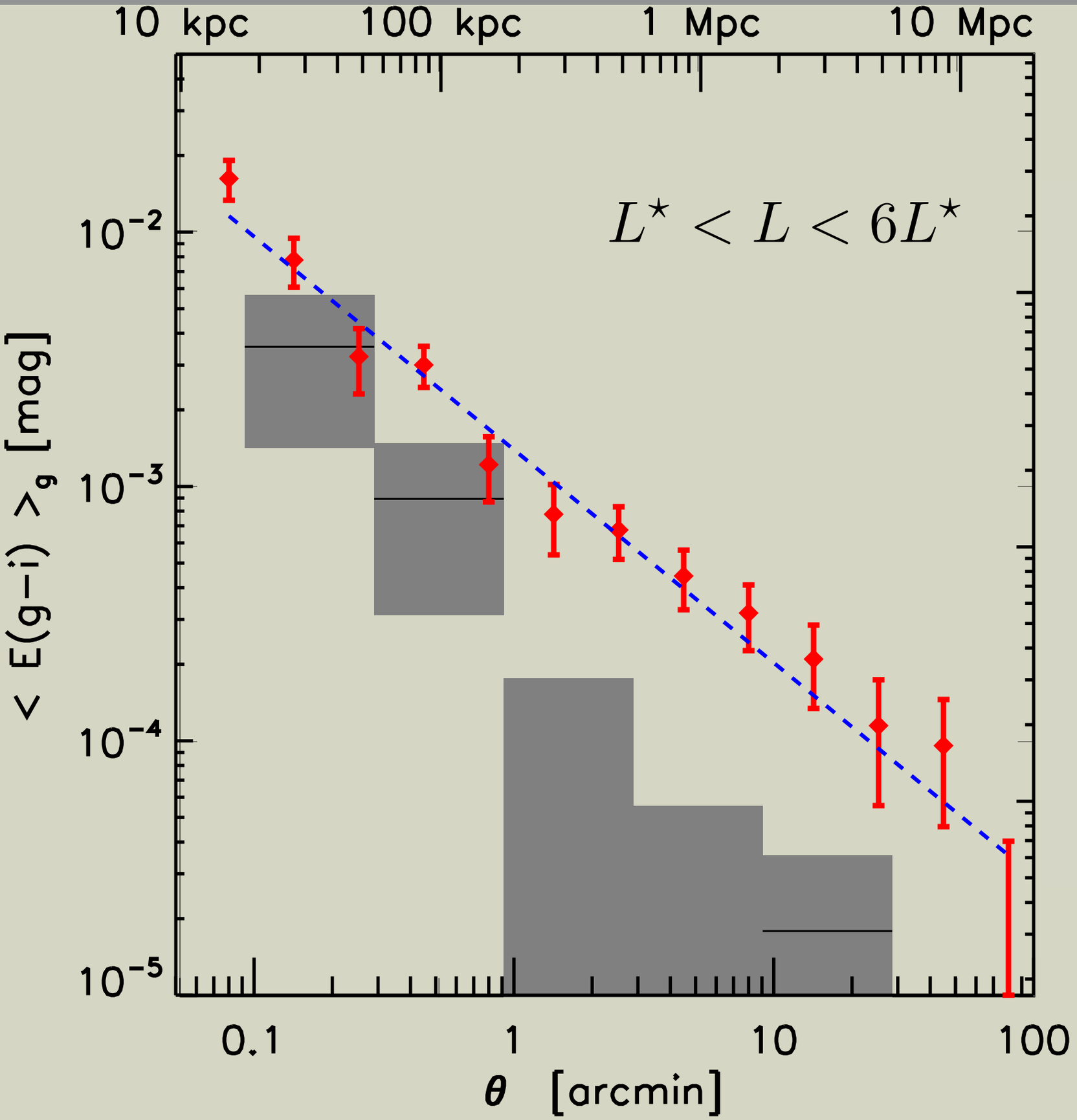
Ménard+ 10

Dim foreground galaxies do not match quasar results...



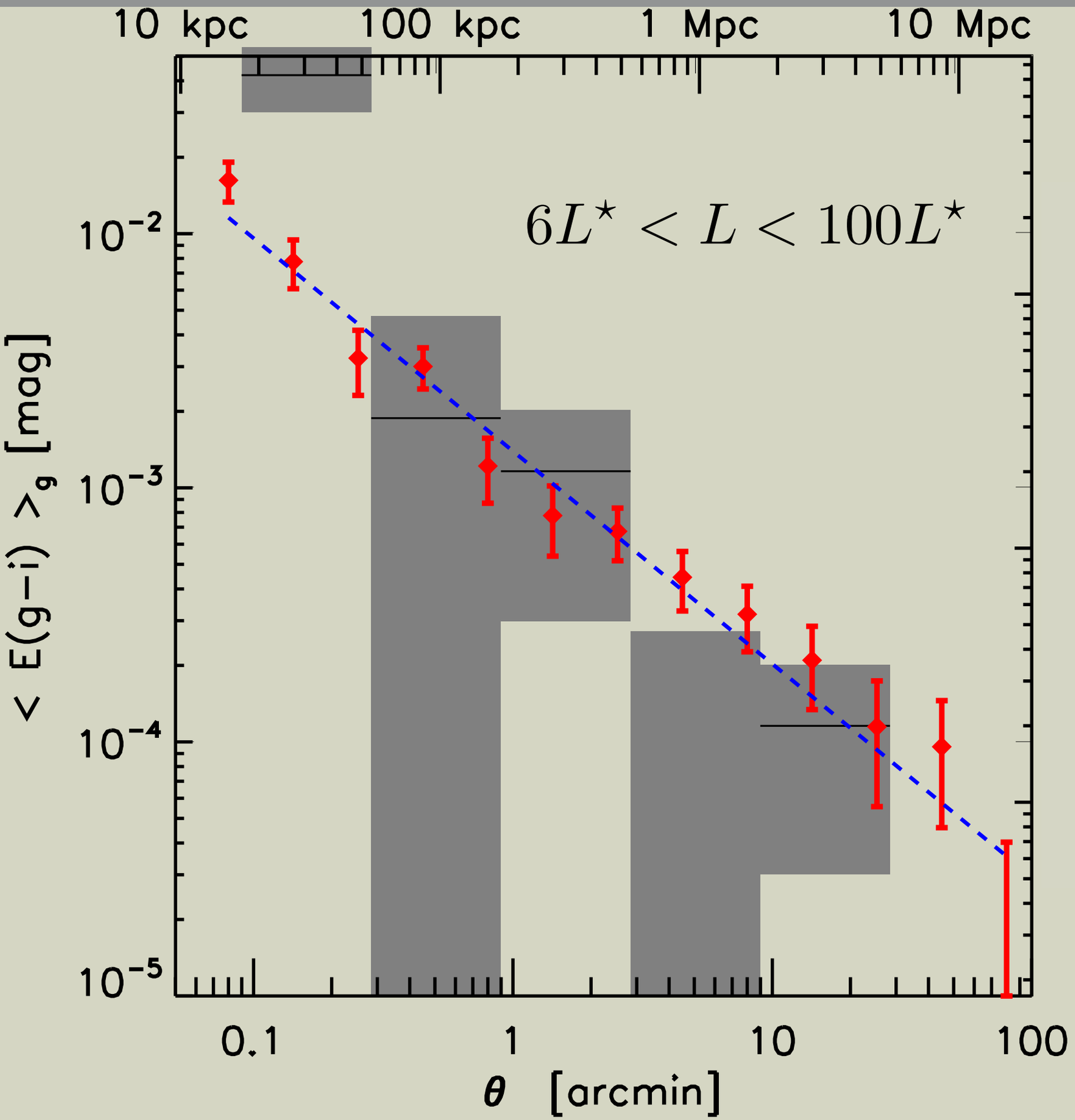
Ménard+ 10

Brighter foreground galaxies do not match quasar results...



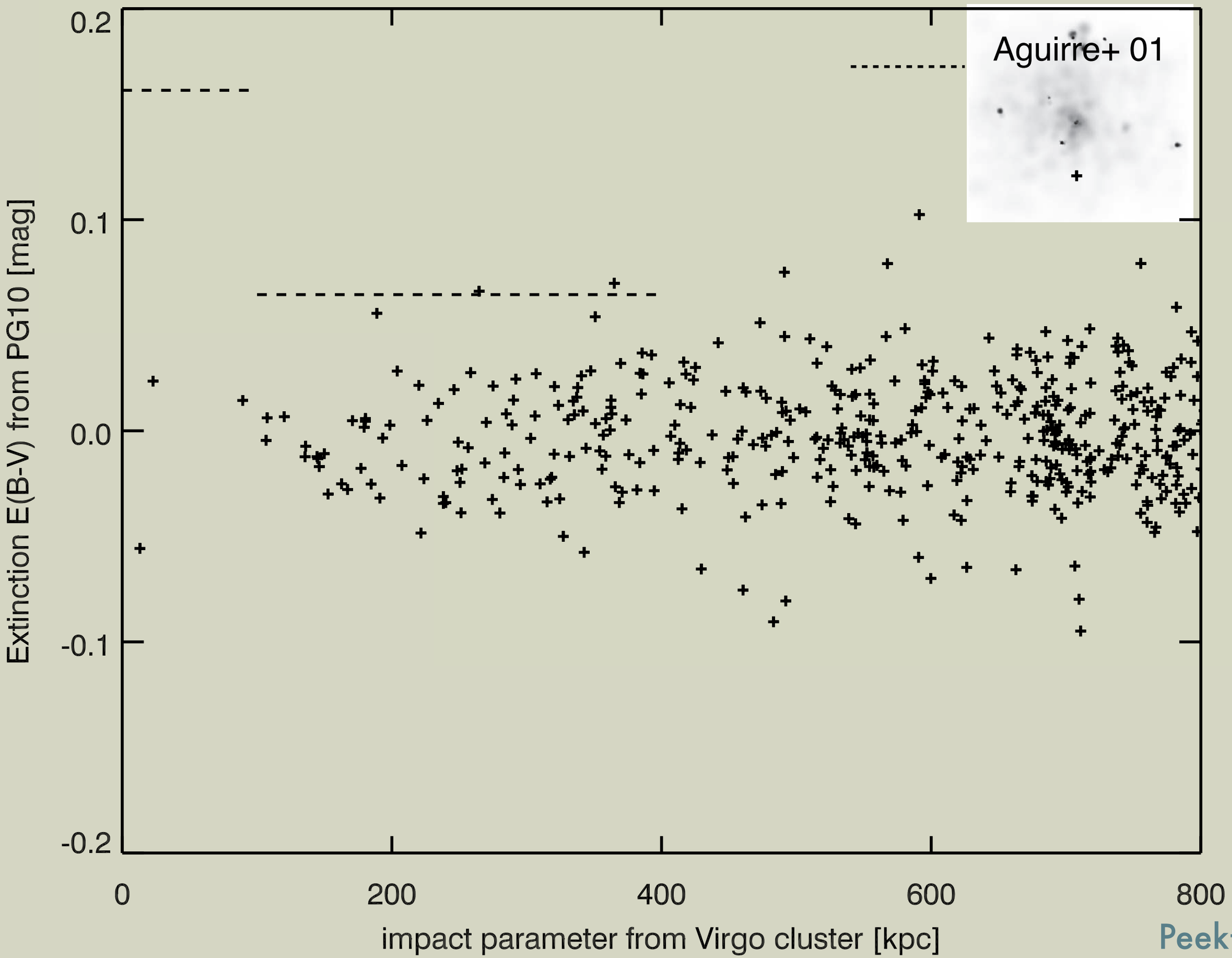
Ménard+ 10

Brightest foreground galaxies reproduce quasar results!



Ménard+ 10

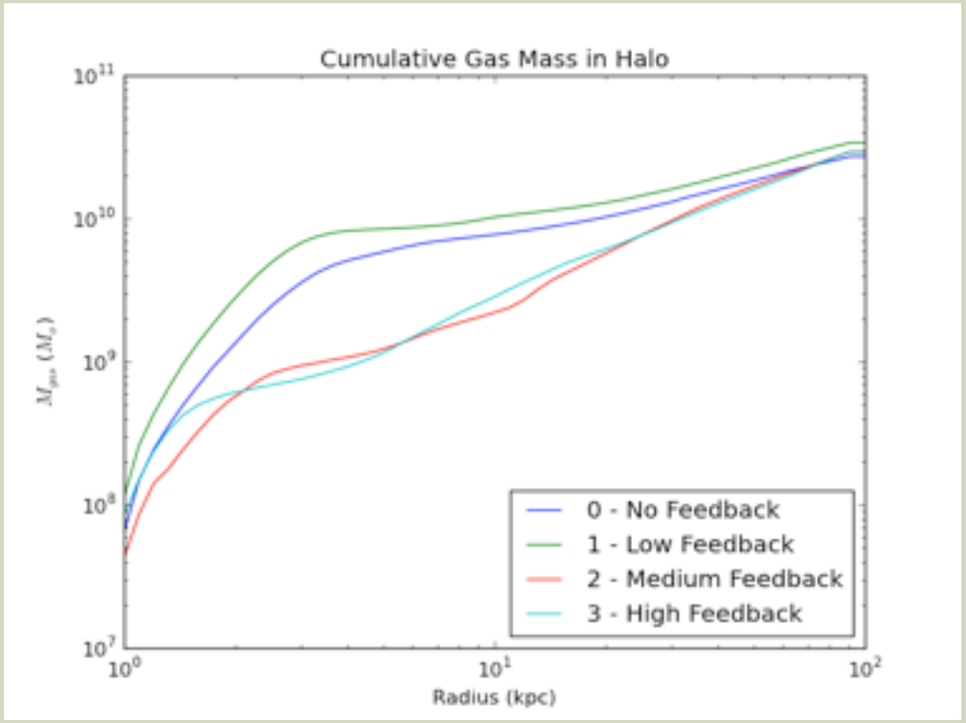
Photon pressure balance overpredicts cluster dust.



Peek+ 12b

Conclusions

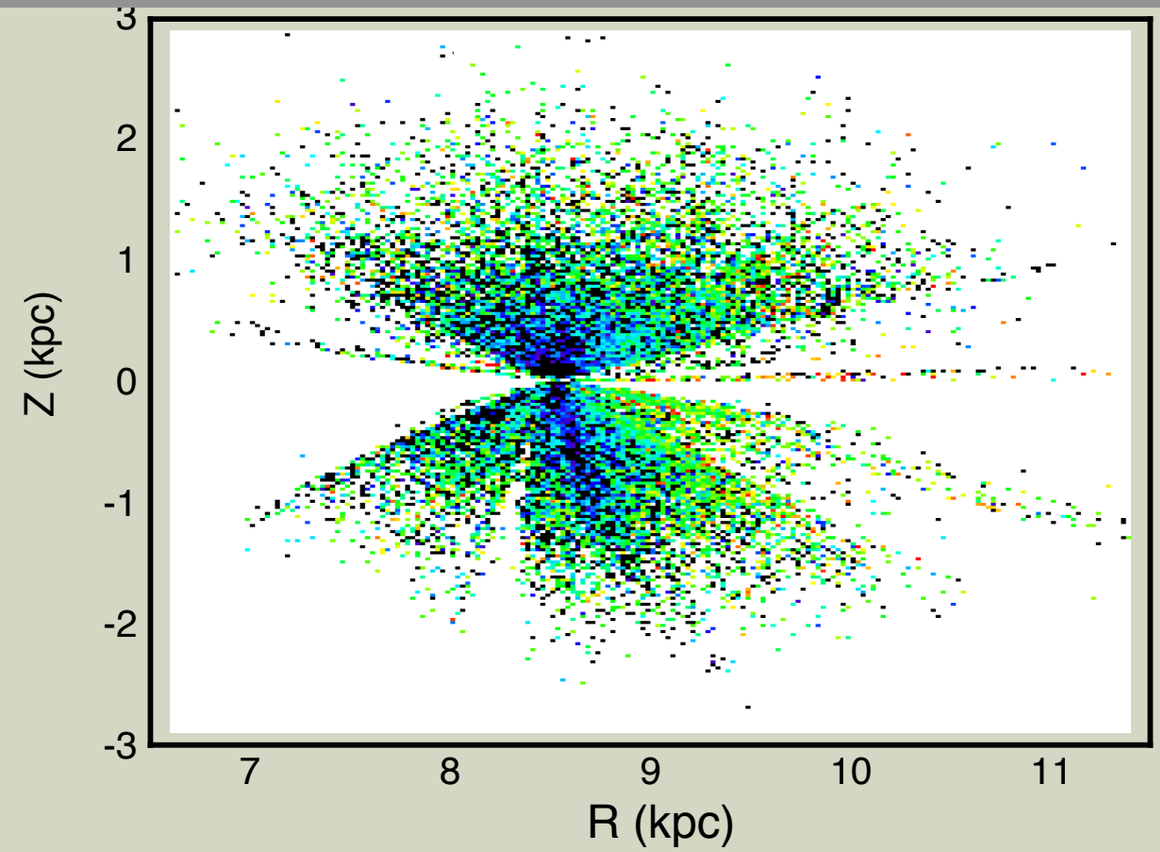
Dust beyond disks allows us
to trace and constrain feedback.



Conclusions

Dust beyond disks allows us
to trace and constrain feedback.

Surveys give us new,
powerful handles on dust.



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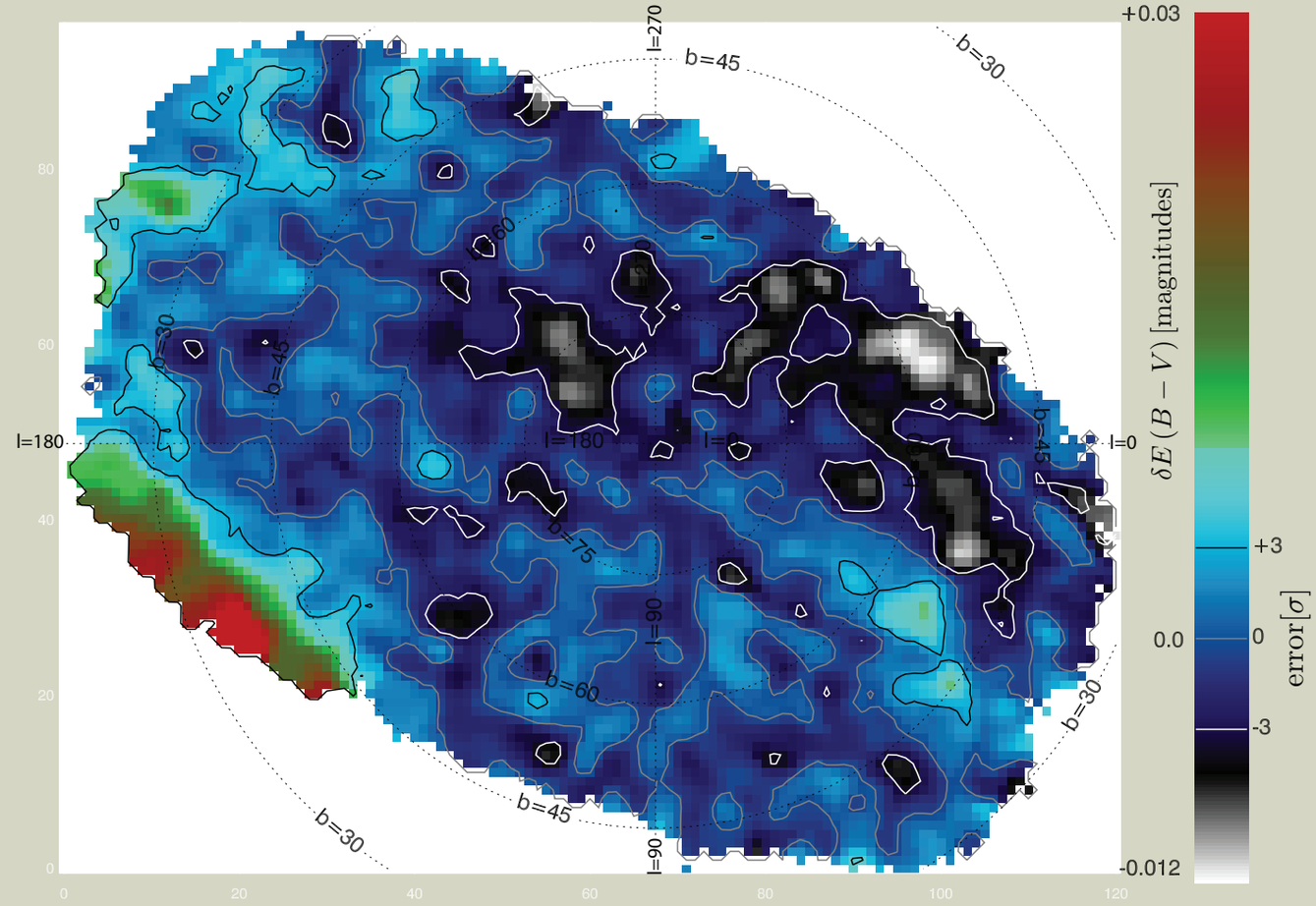

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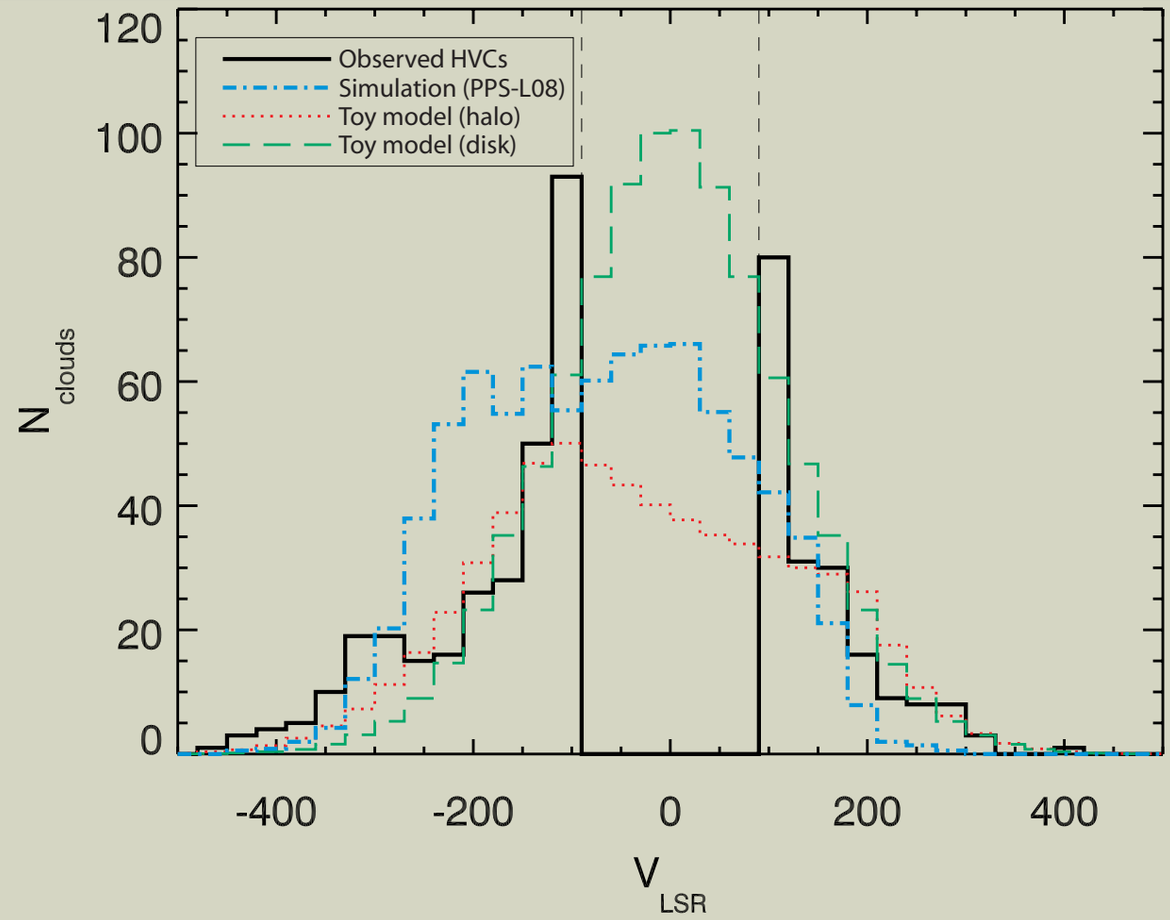

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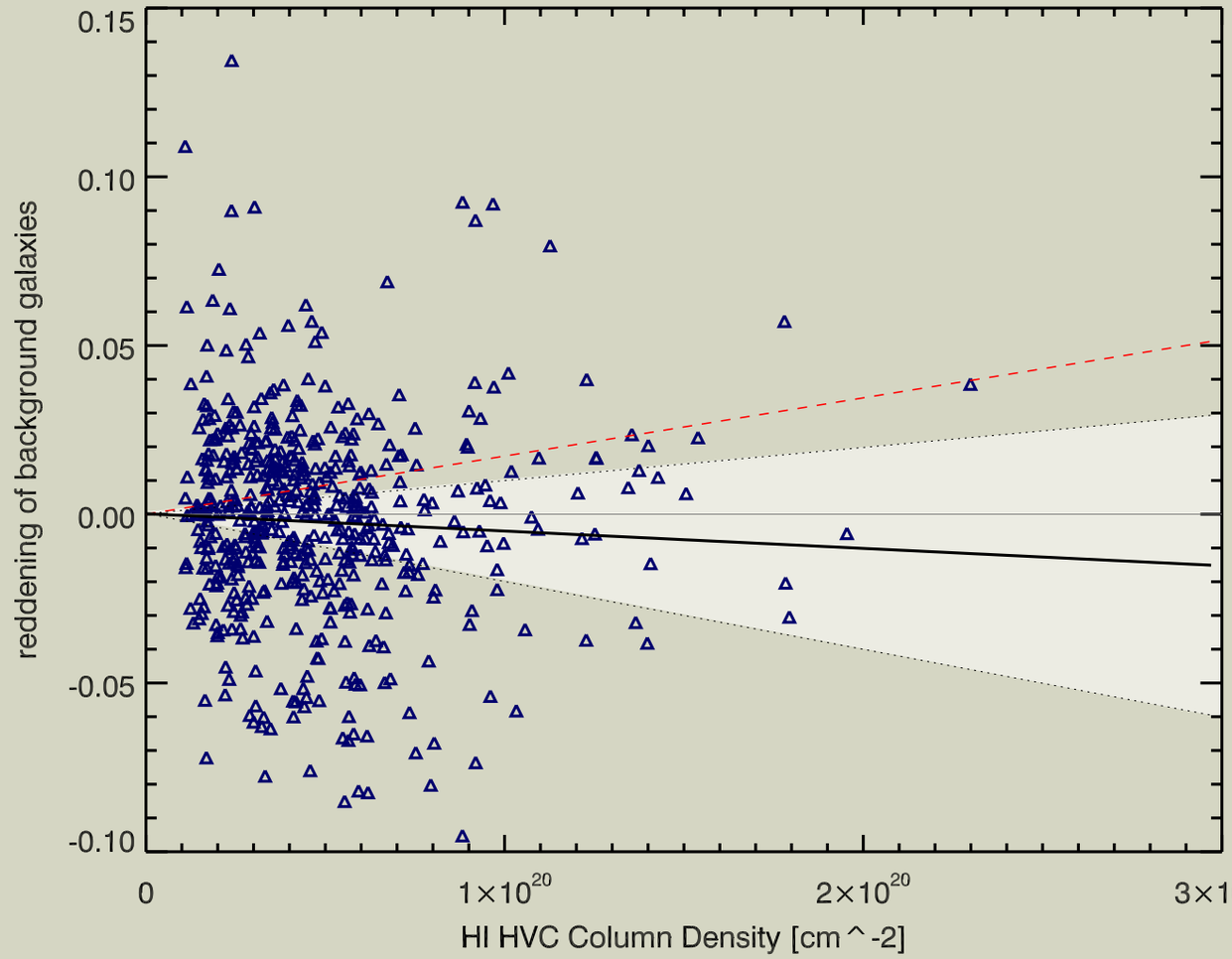

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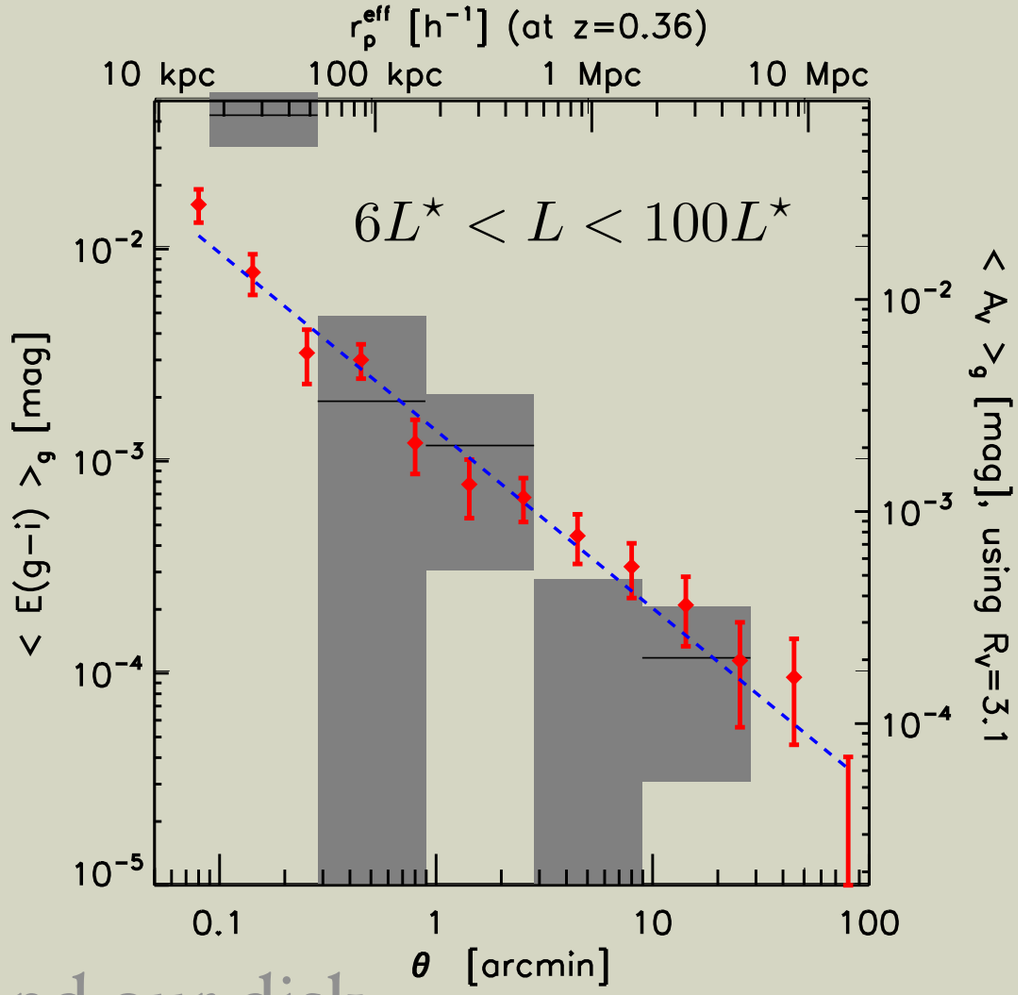

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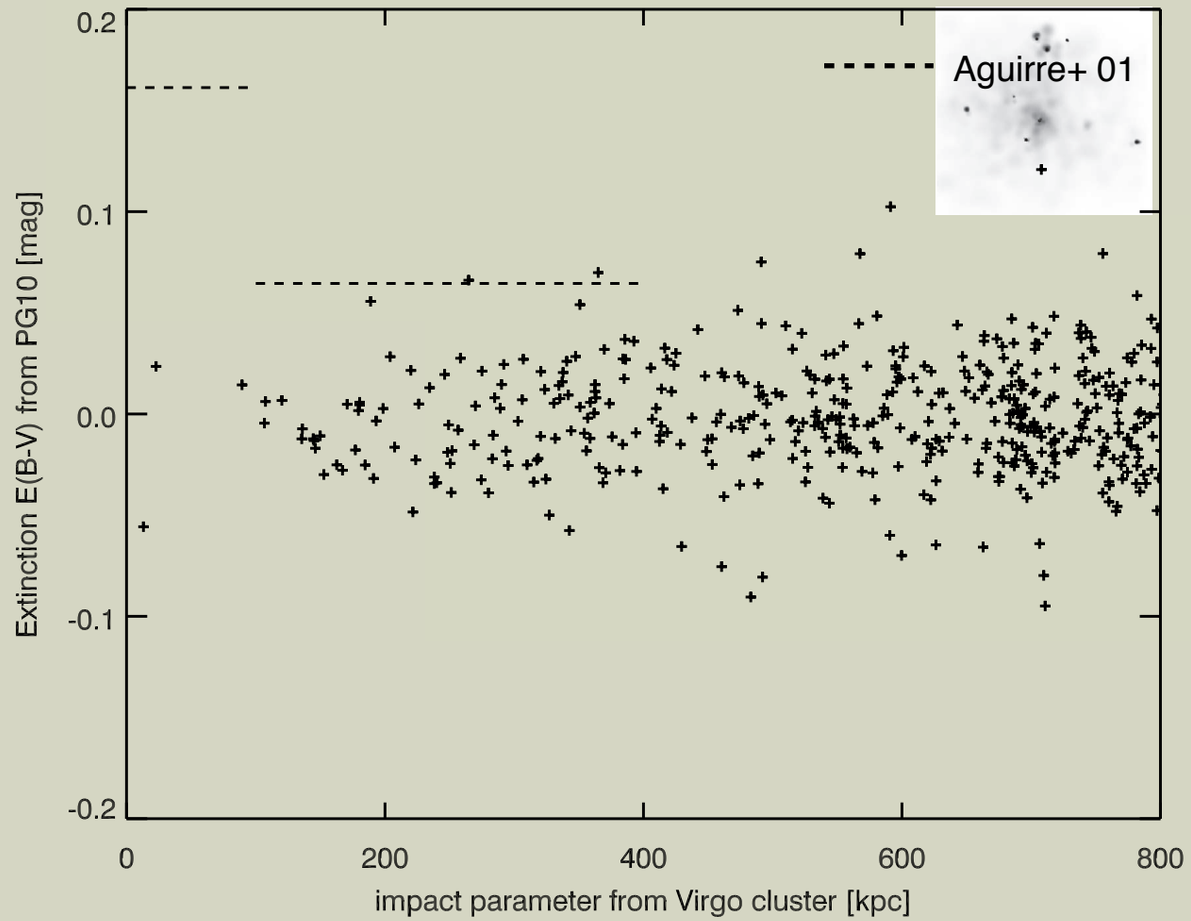

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