

Scattering, Thermal Emission and Extinction: Column Density and Dust Properties

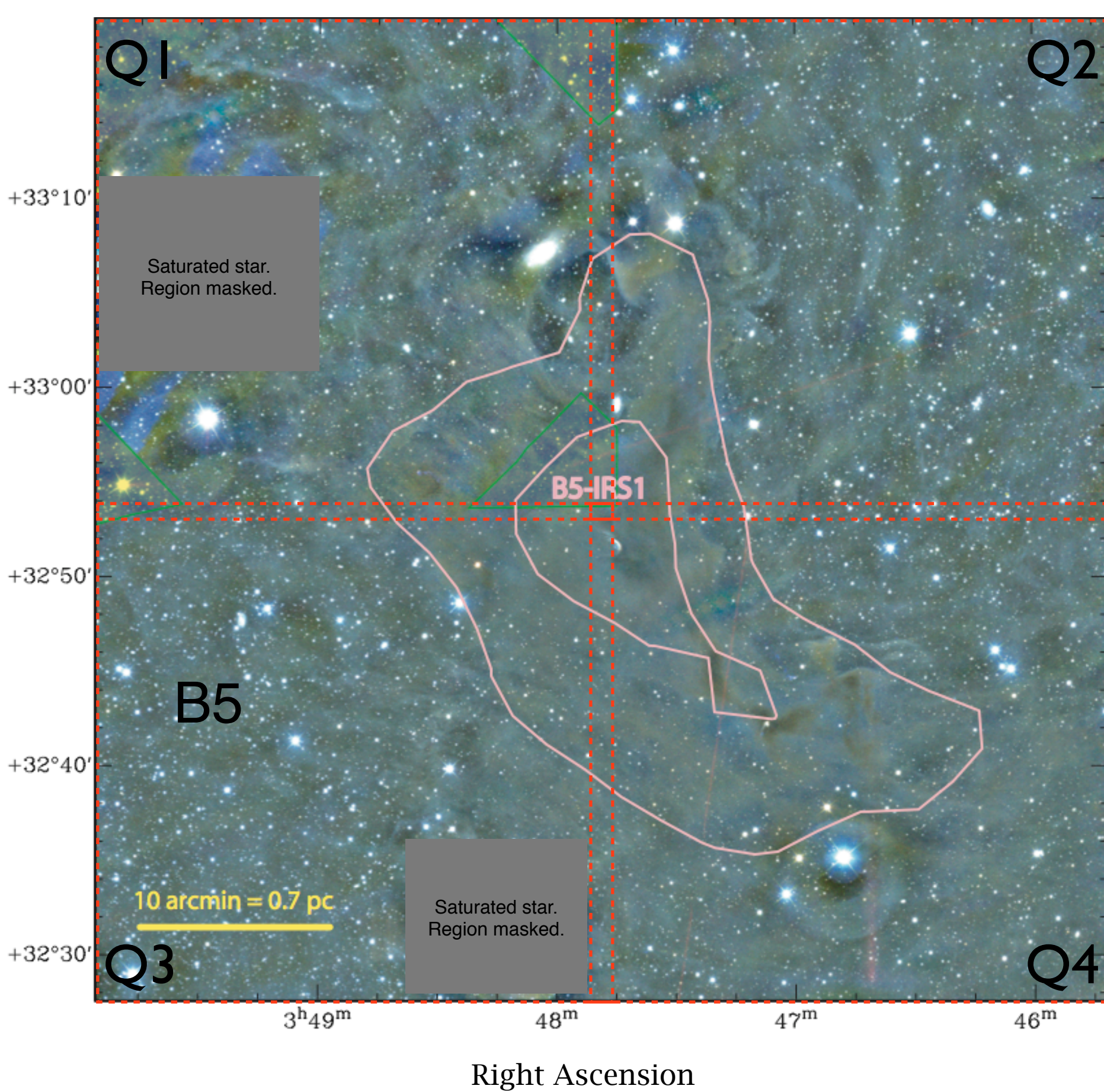
Jonathan Foster (YCAA Fellow, Yale University)



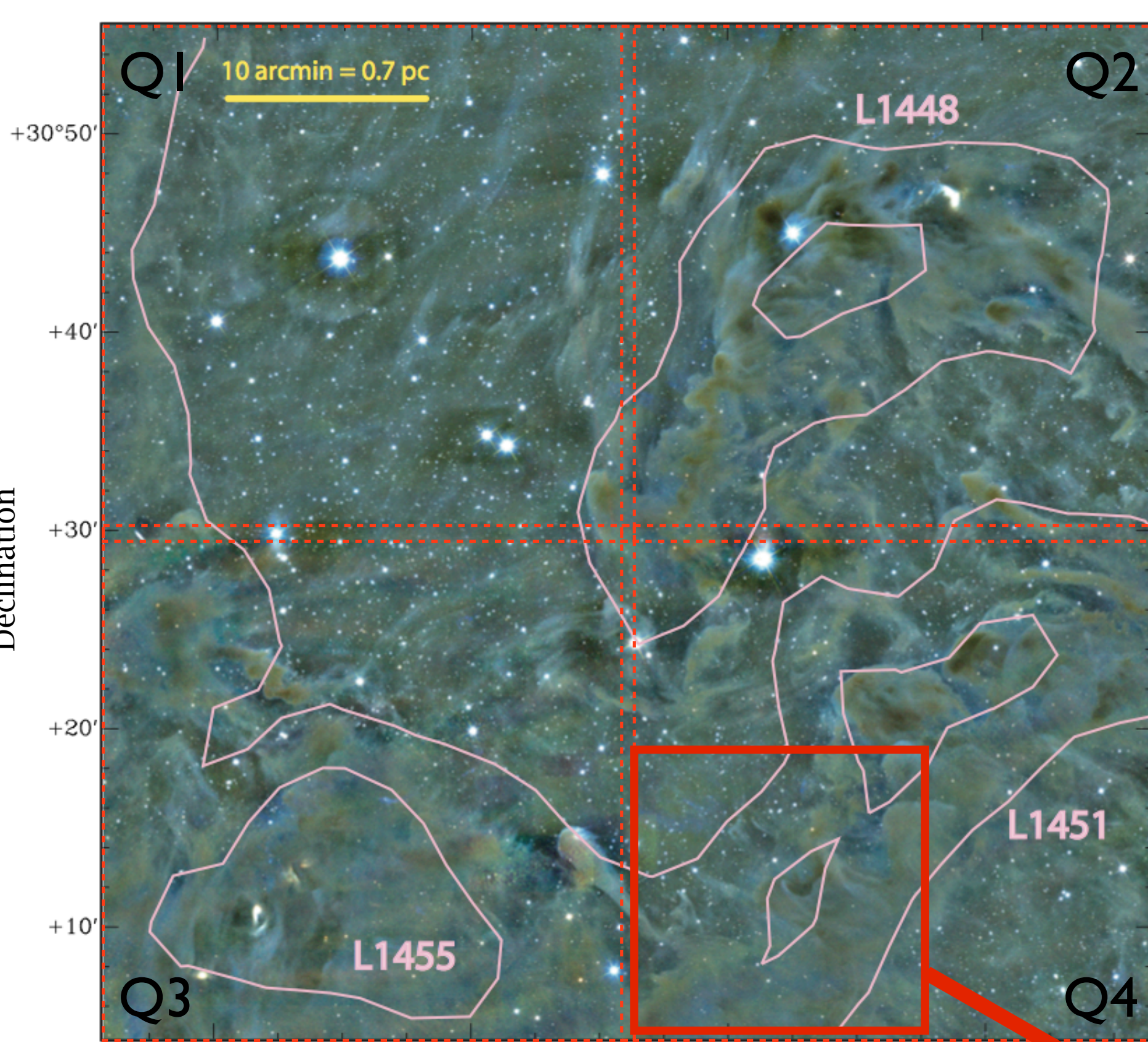
jonathan.b.foster@yale.edu

Data

Megacam on MMT r, i, z + UKIDSS GPS/GCS J, H, K (not shown)



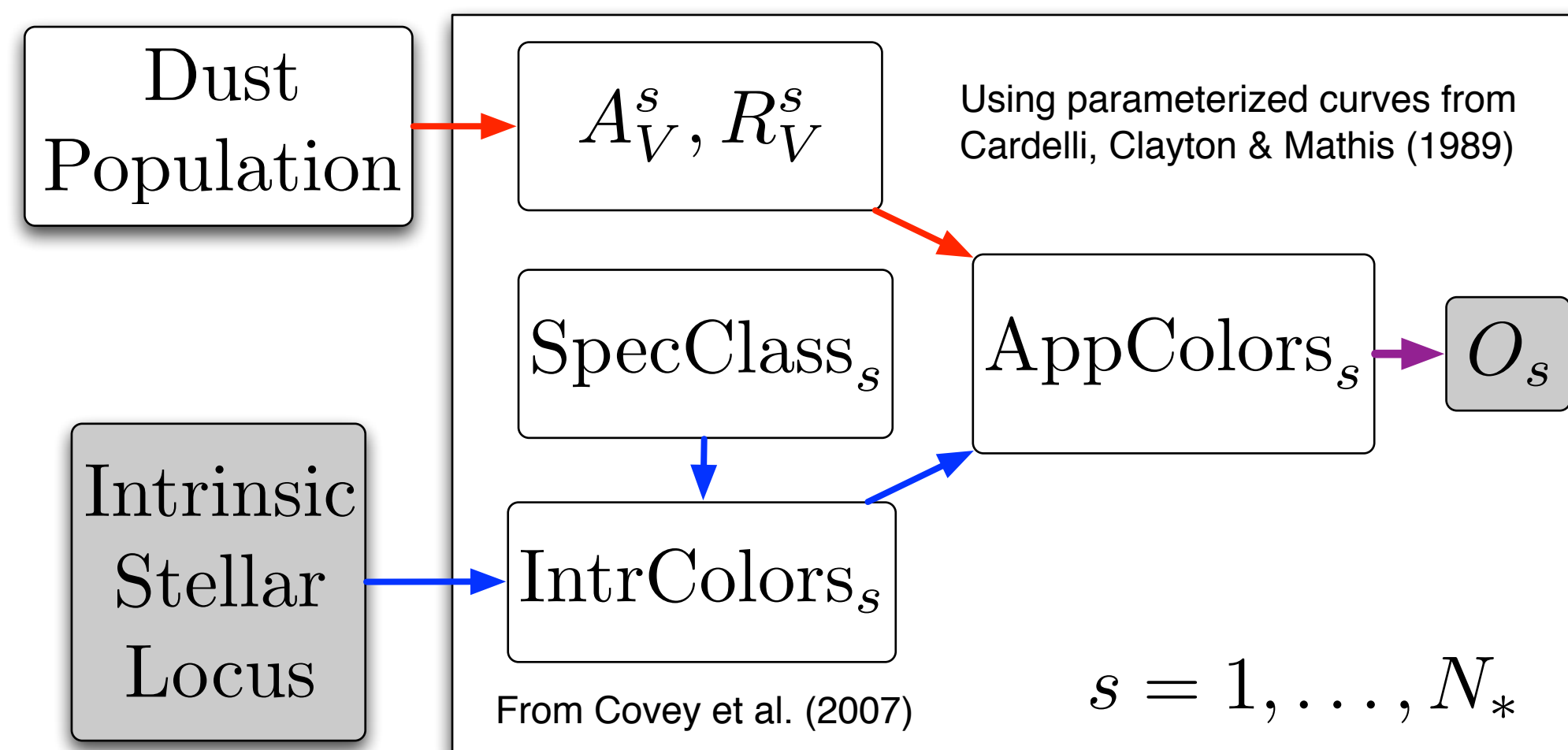
Right Ascension



Right Ascension

Model

Hierarchical Bayesian model simultaneously infers the properties of each star and the full population.



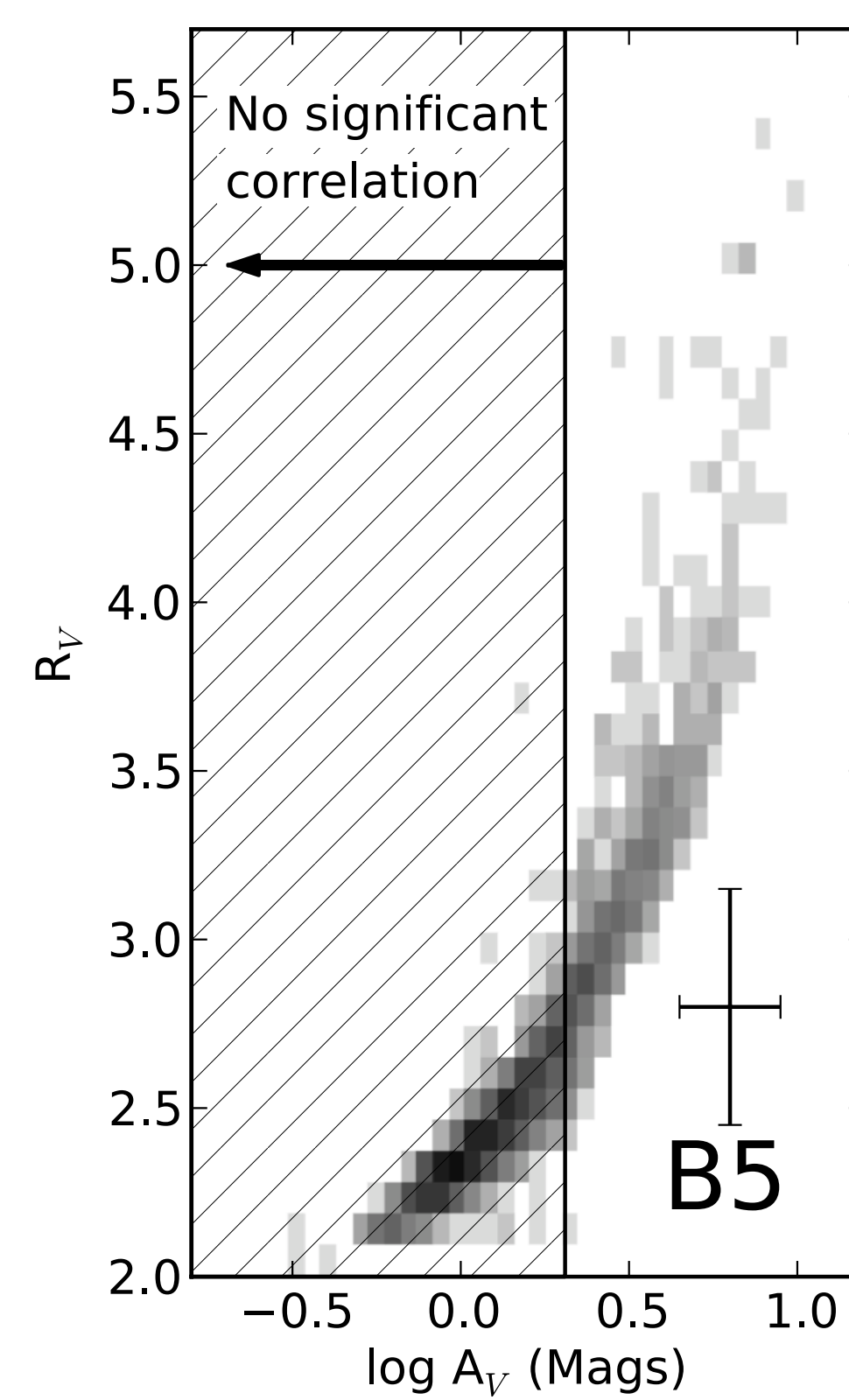
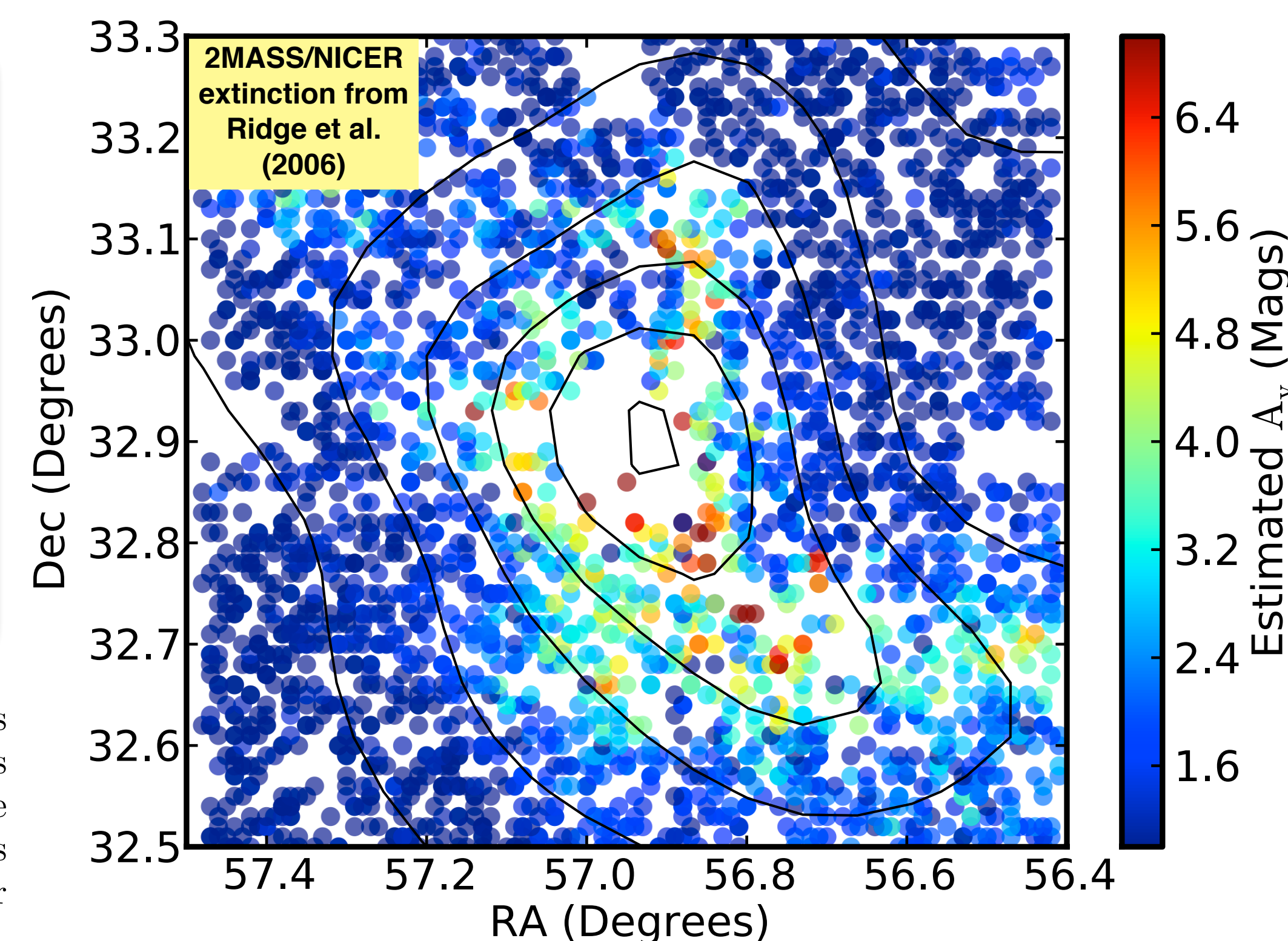
We denote the intrinsic stellar colour as $x \equiv g-i$, and denote the parameters and data for each of N stars with the label s , the suite of hyper-parameters as $\mathbf{H} = [\mu_r, \sigma_r^2, \alpha, \sigma^2]$, and the vector of observed colours for each star as \mathbf{O}^s . The hyper-parameters describe the mean and standard deviation of the distributions in A_V , R_V , and their covariance (α). We then compute the global posterior distribution:

$$P(\{A_V^s, r_V^s, x_s\}; \mathbf{H} | \{\mathbf{O}^s\}) \propto \prod_{s=1}^N \left[P(\mathbf{O}^s | x_s, A_V^s, r_V^s) \times P(x_s, A_V^s, r_V^s | \mathbf{H}) \right] \times P(\mathbf{H})$$

Foster, Mandel, Pineda, Covey, Arce, Goodman (2013)
MNRAS 428 1606, <http://arxiv.org/abs/1210.2391>
Support from NSF AST-0908159, AST-0407172, AST-0907903

Dust extinction is just one way to estimate the column density of a molecular cloud

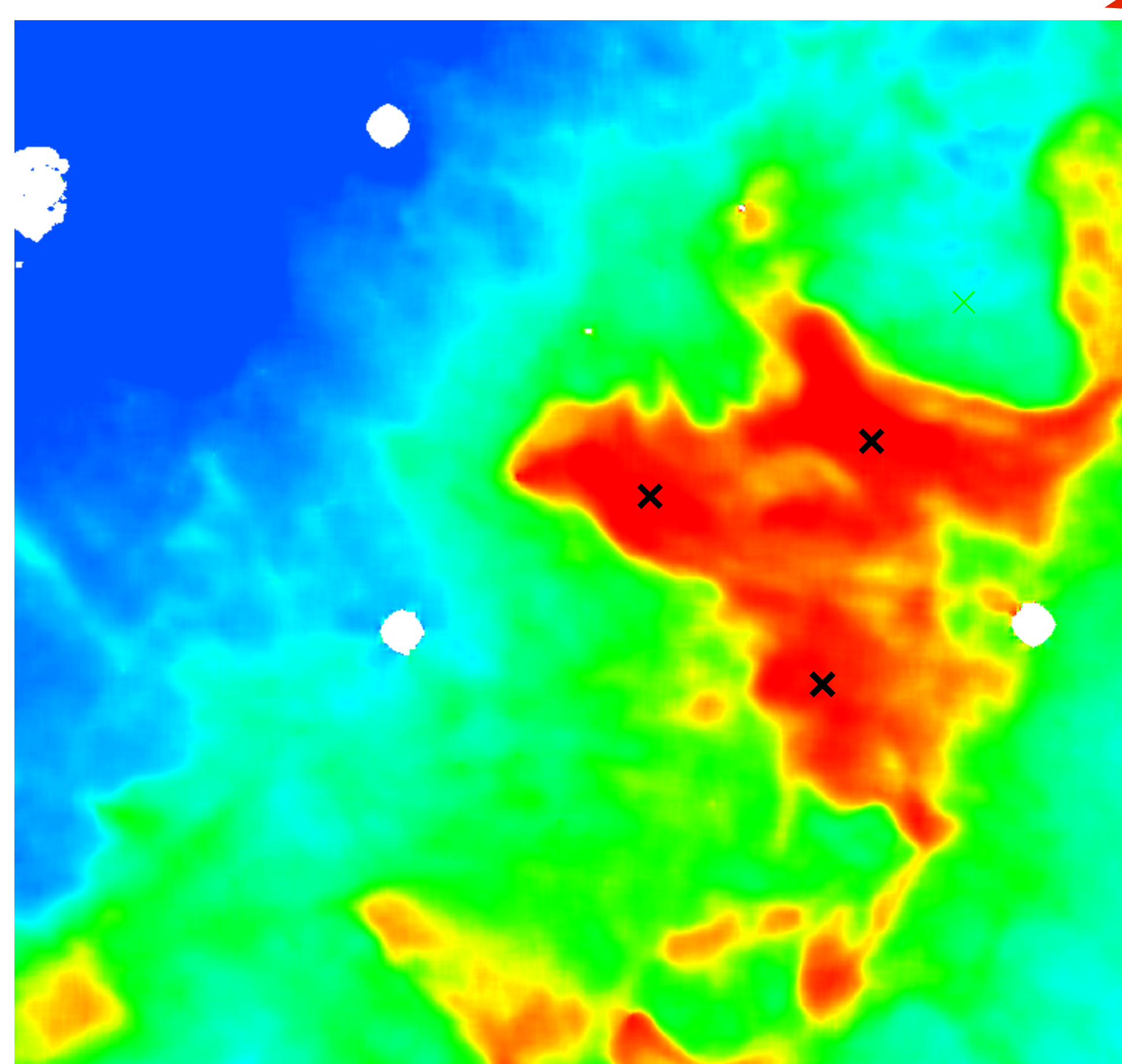
Results



Conclusion: We infer a correlation (ρ) between A_V and R_V in two regions of Perseus; both regions exhibit a similar trend. This trend is significant above $A_V = 2$ mags.

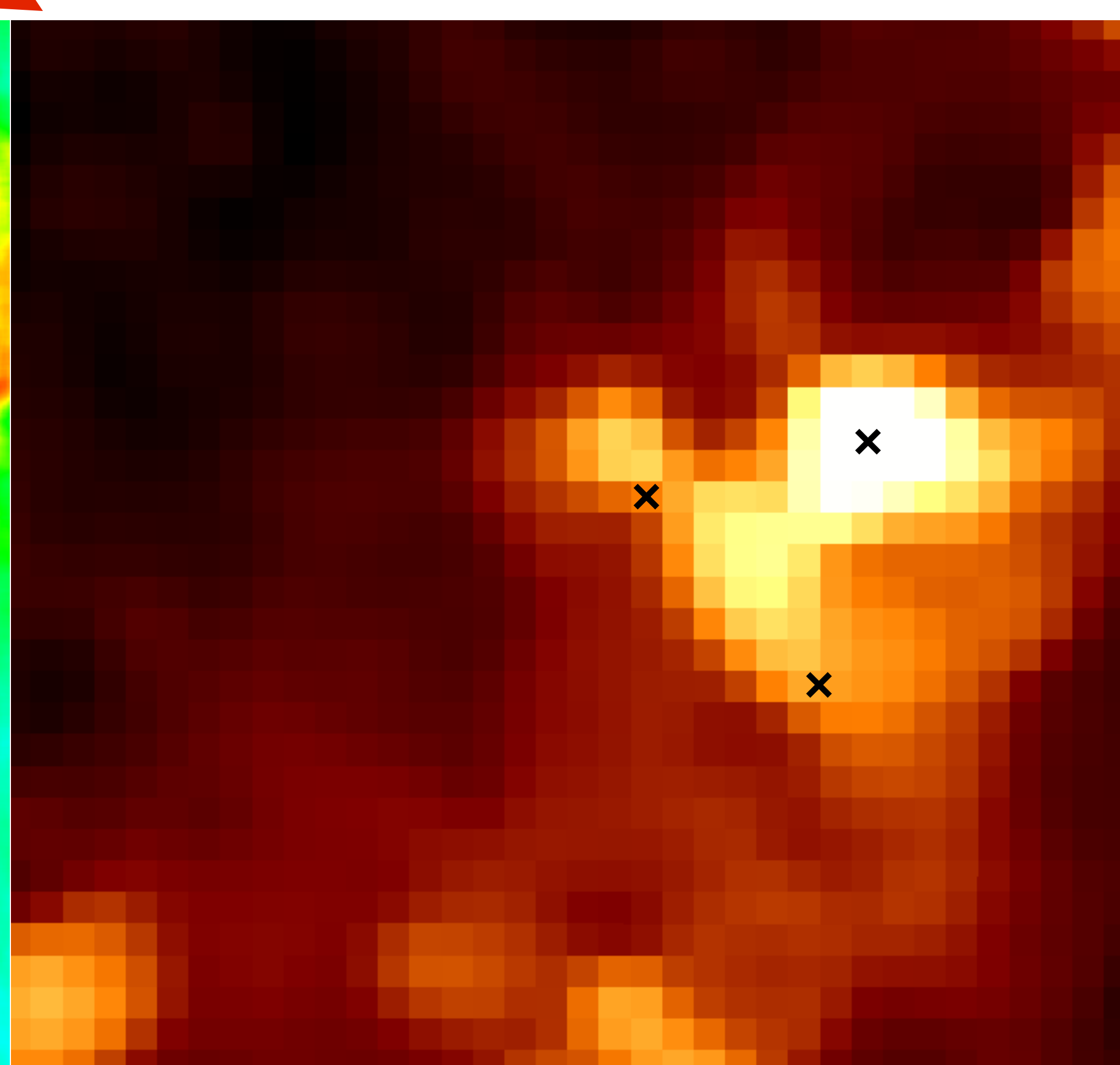
To connect this trend to physical models, we assume that for centrally condensed regions in molecular clouds, $R_V \propto \langle a \rangle \propto n \propto A_V$, where n is the volume density and $\langle a \rangle$ the average size of dust grains.

The sense of the correlation is that R_V increases with increasing A_V , consistent with other studies at higher column density, and well explained by grain growth in dense regions.



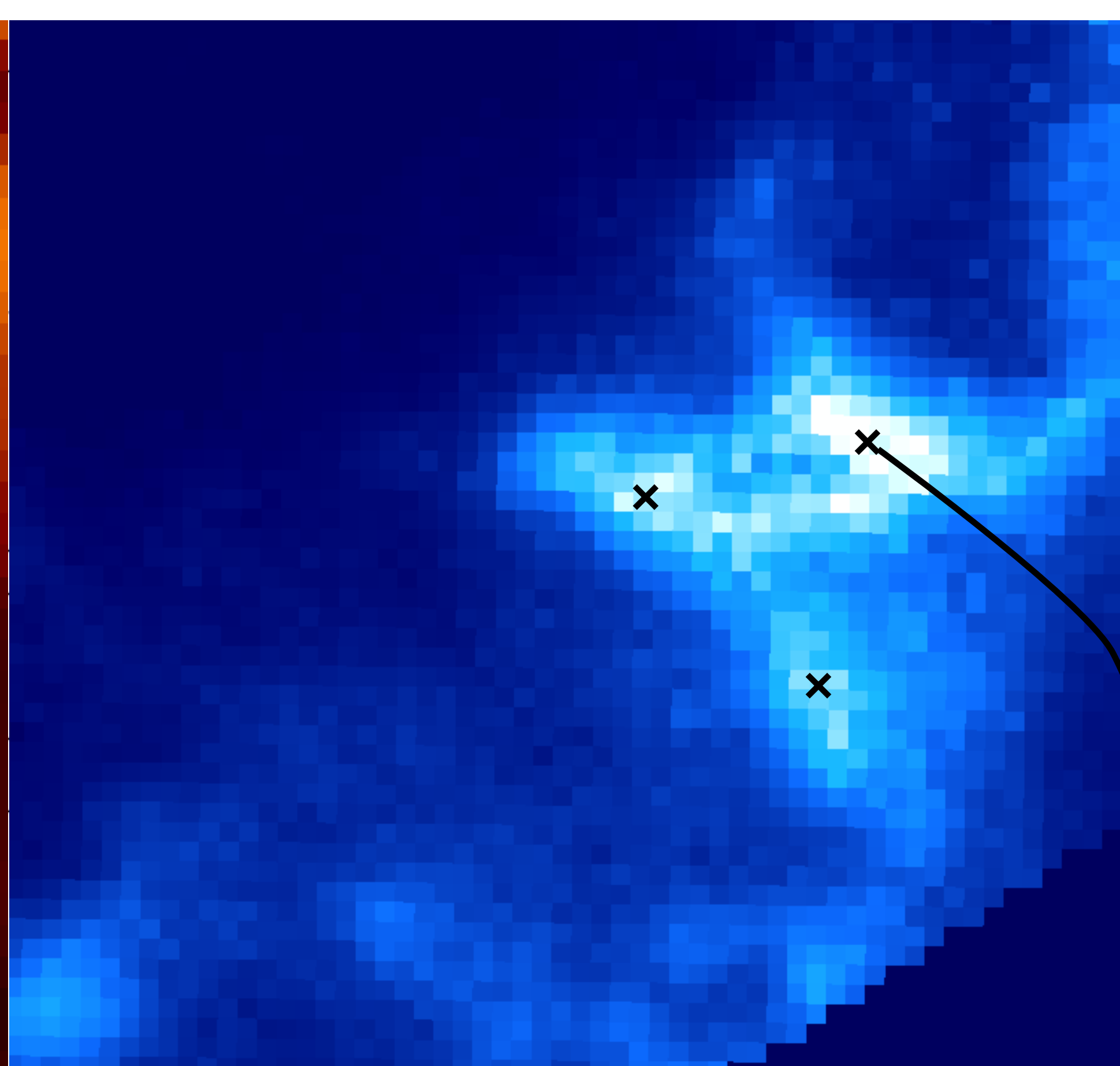
Scattered (aka Cloudshine)

Dust scattering efficiency and phase function



Extinction (GNICER)

Dust extinction (absorption + scattering)



Thermal Emission (Herschel)

Dust emissivity and temperature

