Extinction mapping of the IC63 photodissociation region using Hubble data

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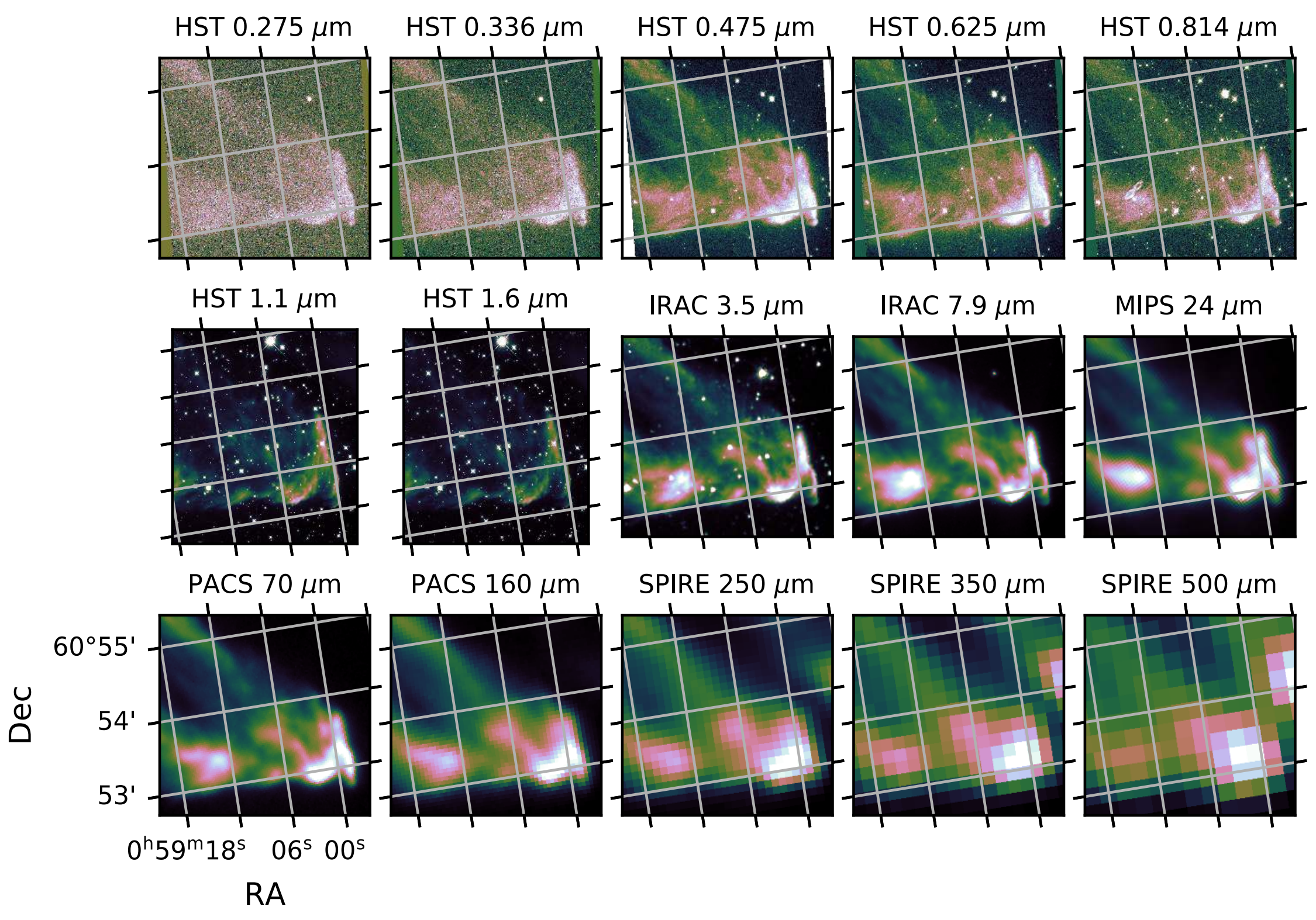
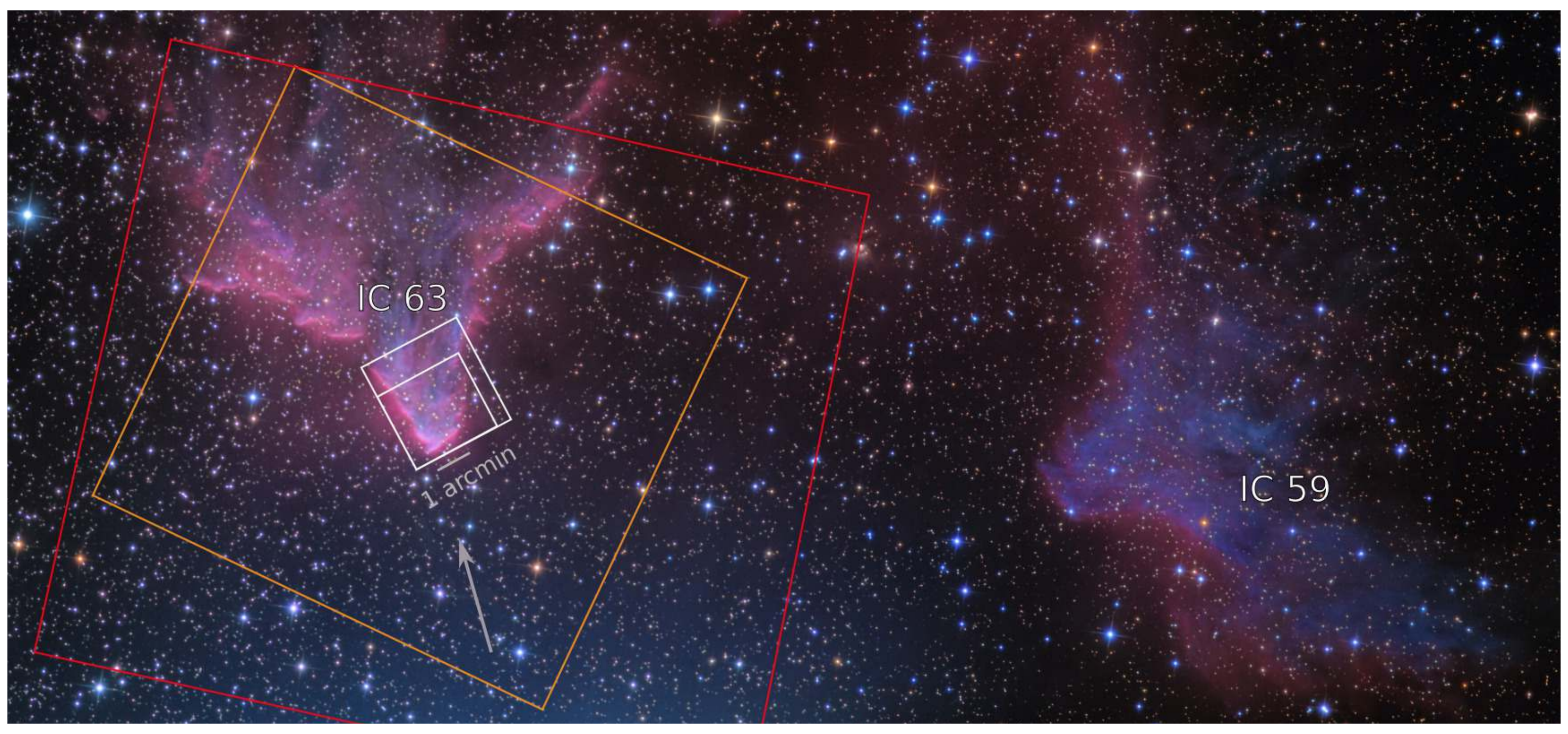
Observational data and analysis

Observations and retrieved data

- HST WFC3 observations UVIS and IR
- Archive data from Spitzer IRAC/MIPS and Herschel PACS/SPIRE

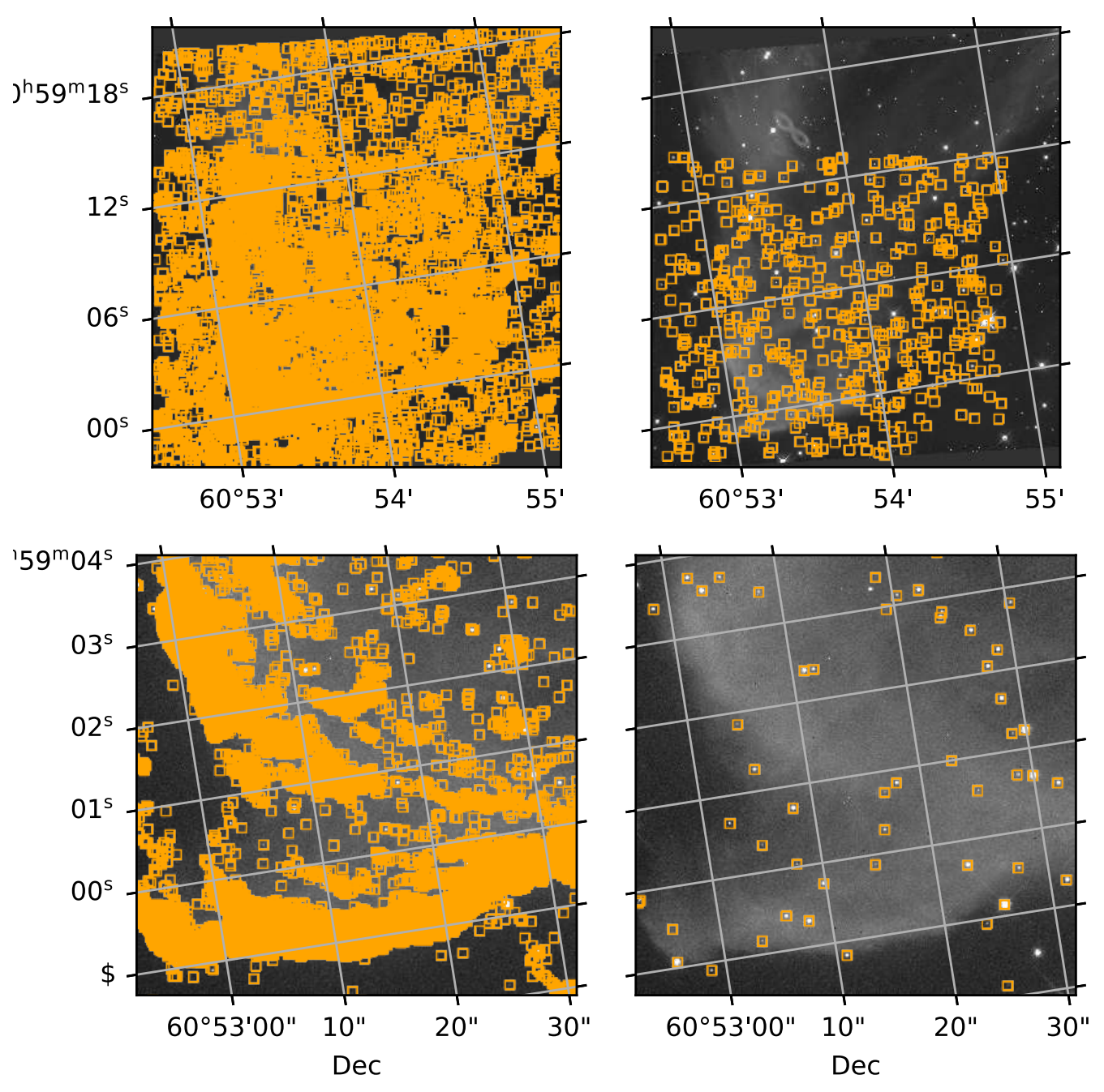




White: HST UVIS and IR; Orange: Spitzer MIPS; Red: Herschel SPIRE (picture credit: Ken Crawford)

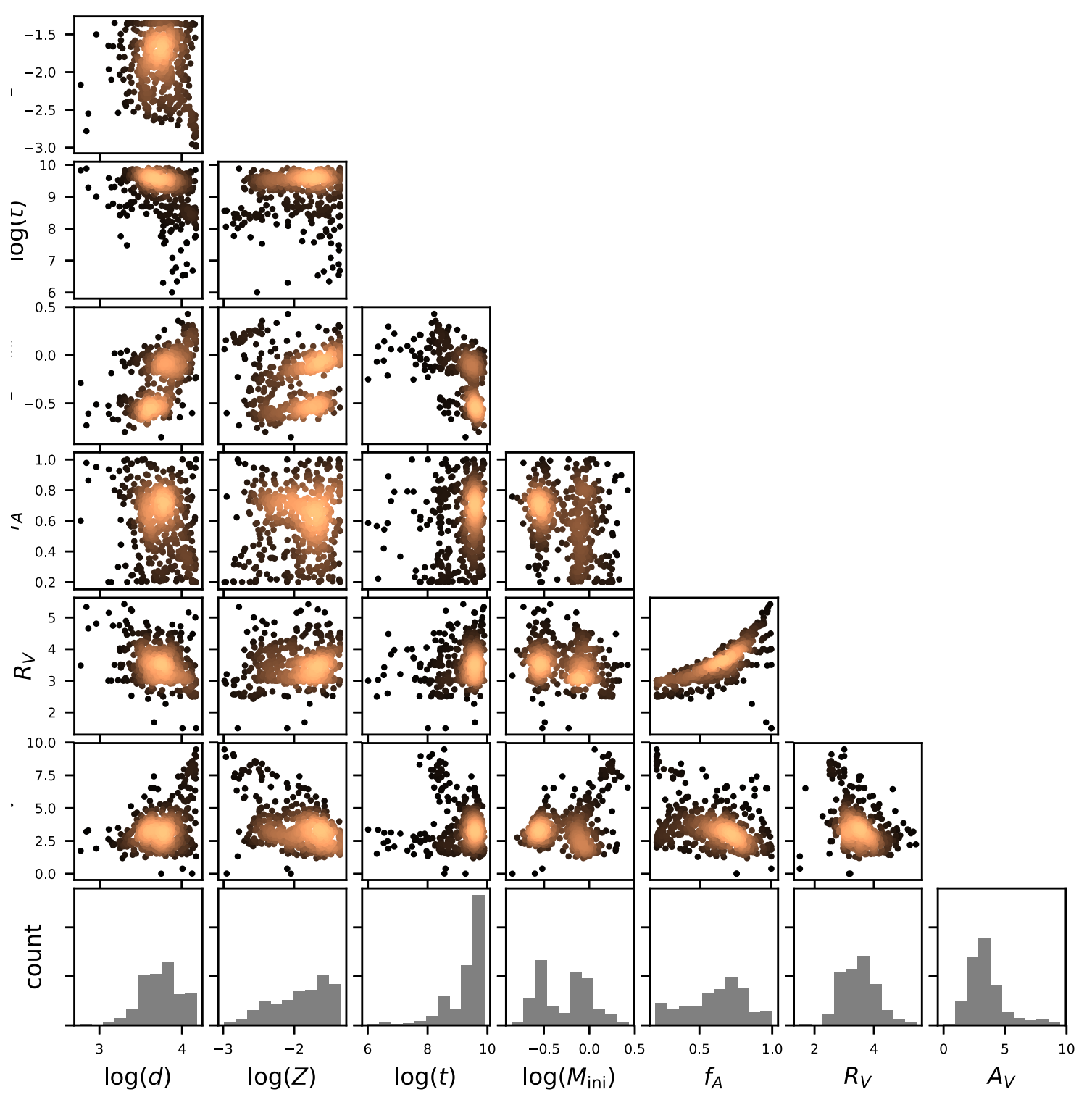
Point source extraction

- Fluxes in the 7 HST bands
- Same pipeline that was used for PHAT, a survey of point sources in Andromeda (Williams et al. 2014)
- We apply cuts on the flux error to deal with false positives



Point source fitting

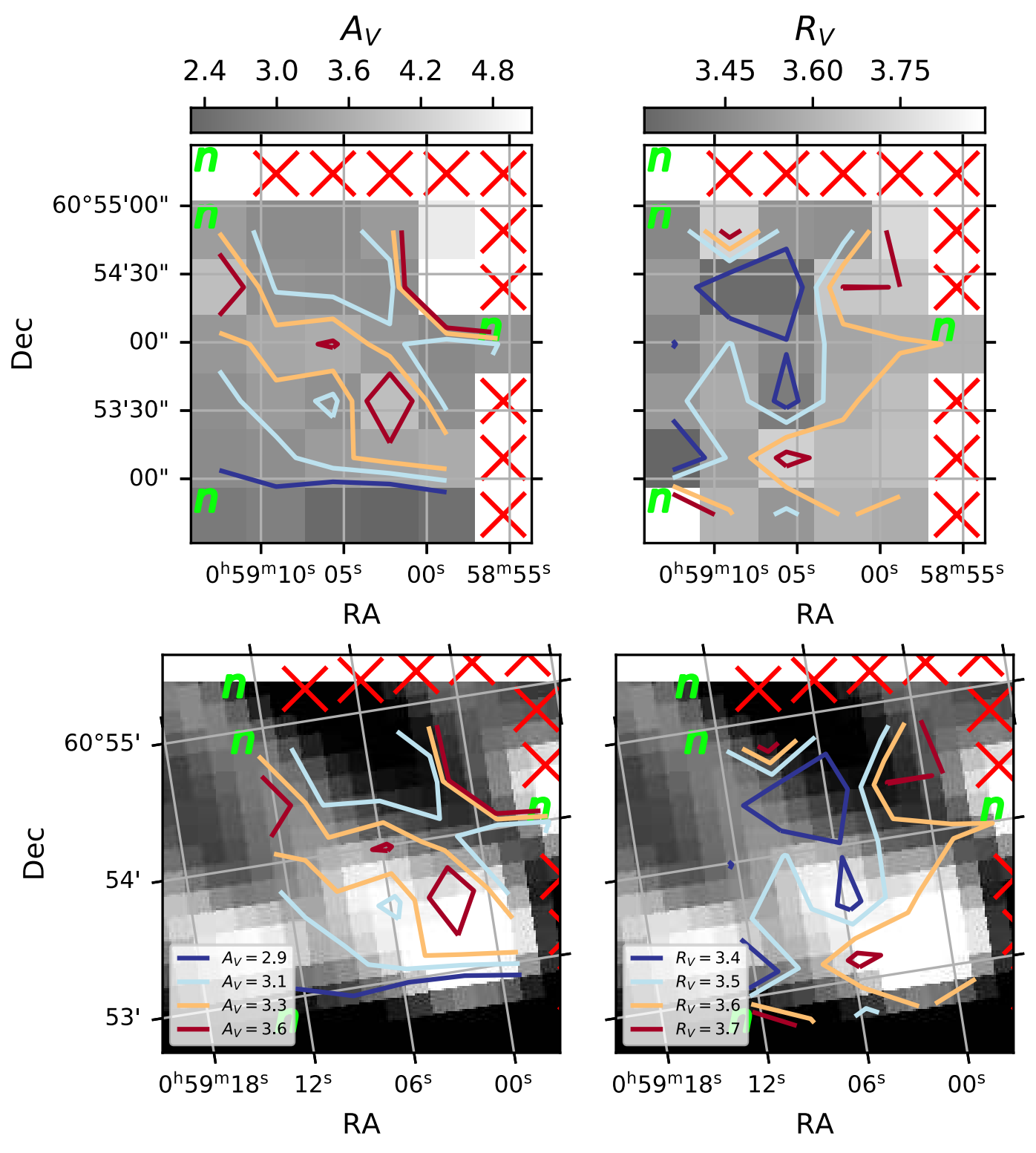
- BEAST: Bayesian Extinction and Stellar Tool (Gordon et al. 2016)
- 4 stellar parameters: mass M, age t, metallicity Z, distance d
- 3 extinction parameters: $A(V)$, $R(V)$, mixing parameter f_A
- We calculate their expectation values for each of the 500 background sources



Results

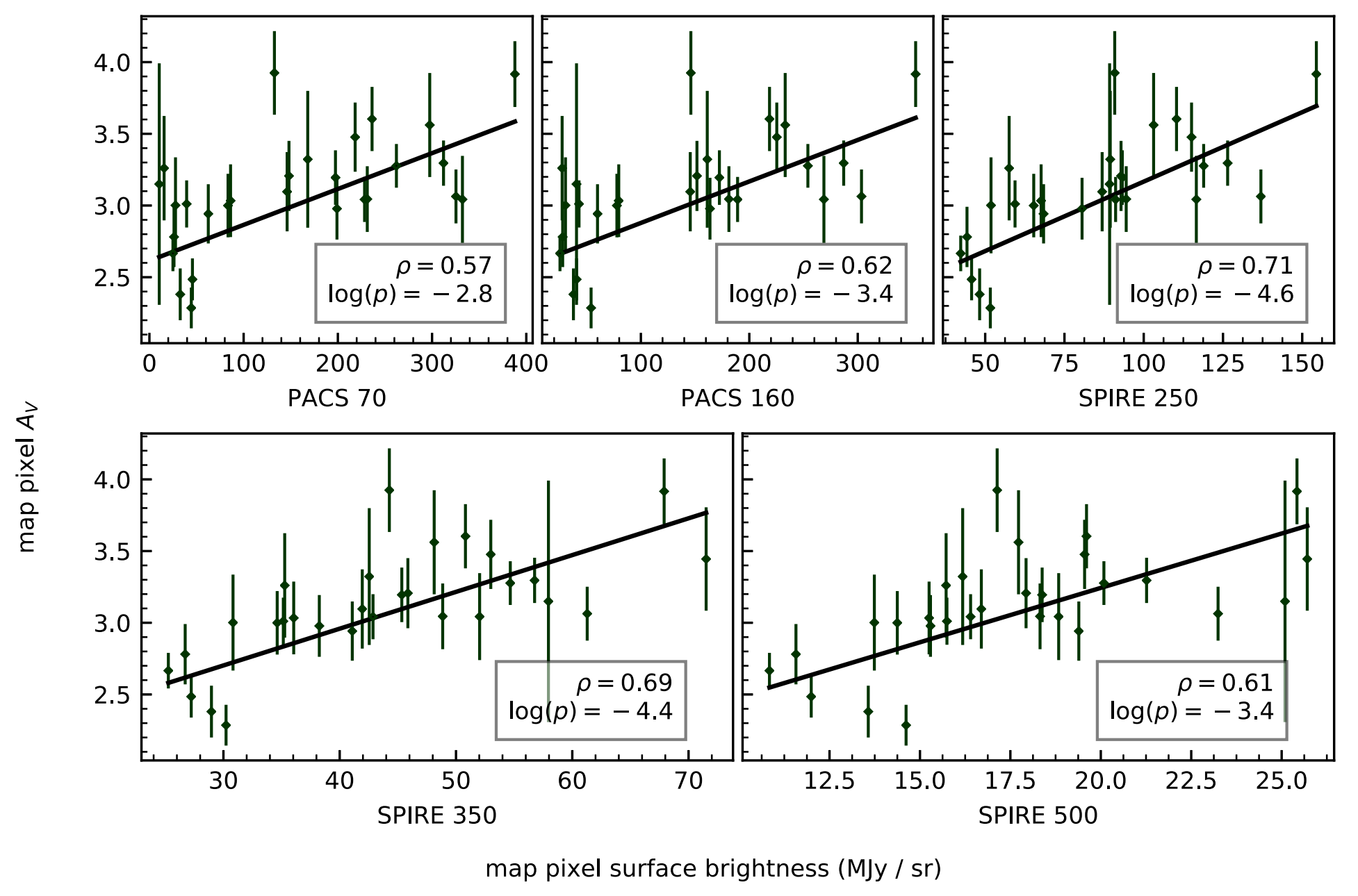
Extinction maps

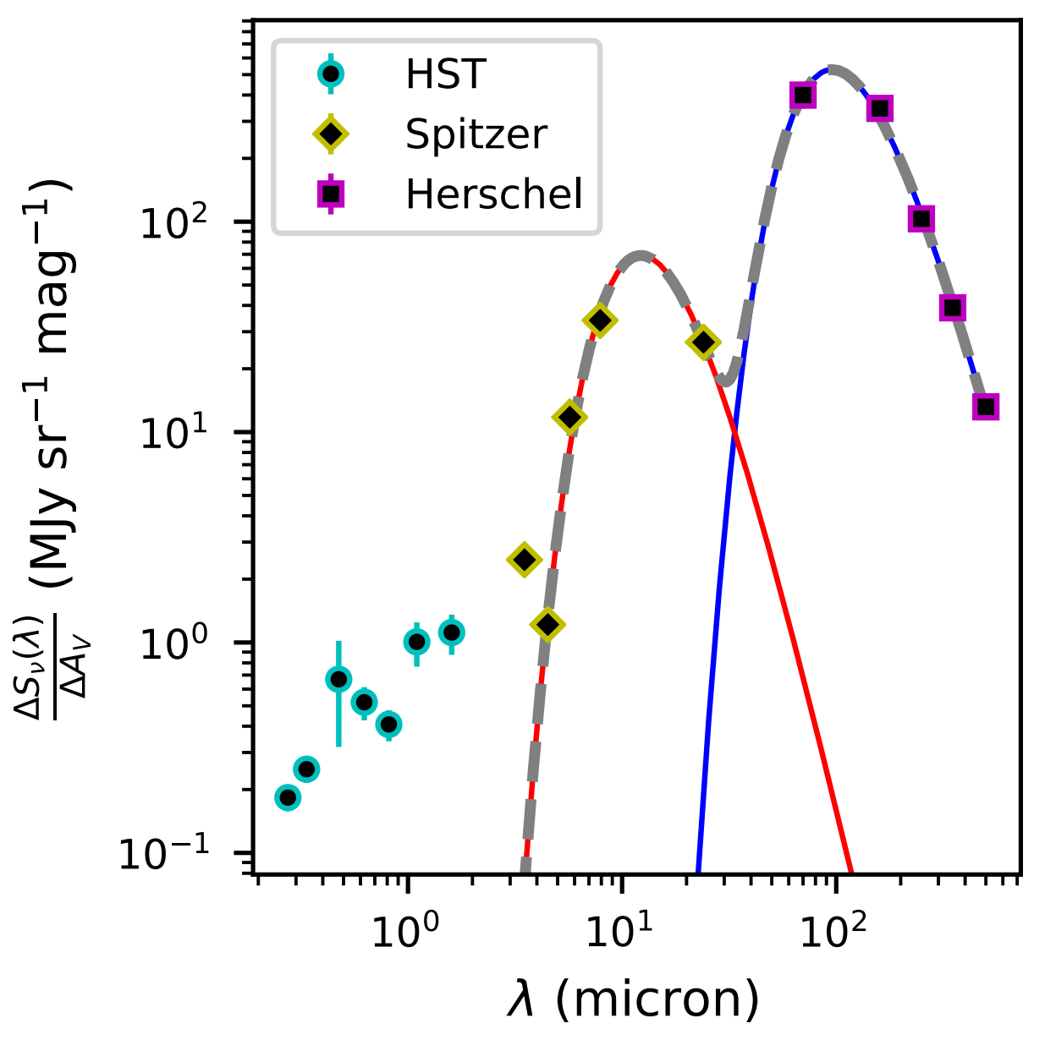
- We generate median A(V) and R(V) maps with pixels of 25" x 25"
- About 10 to 20 sources per pixel
- The bottom plots show the SPIRE 350 data
- A(V) correlates with the FIR flux
- There is a clear decrease in R(V) towards the back of the nebula



A(V)-normalized SED

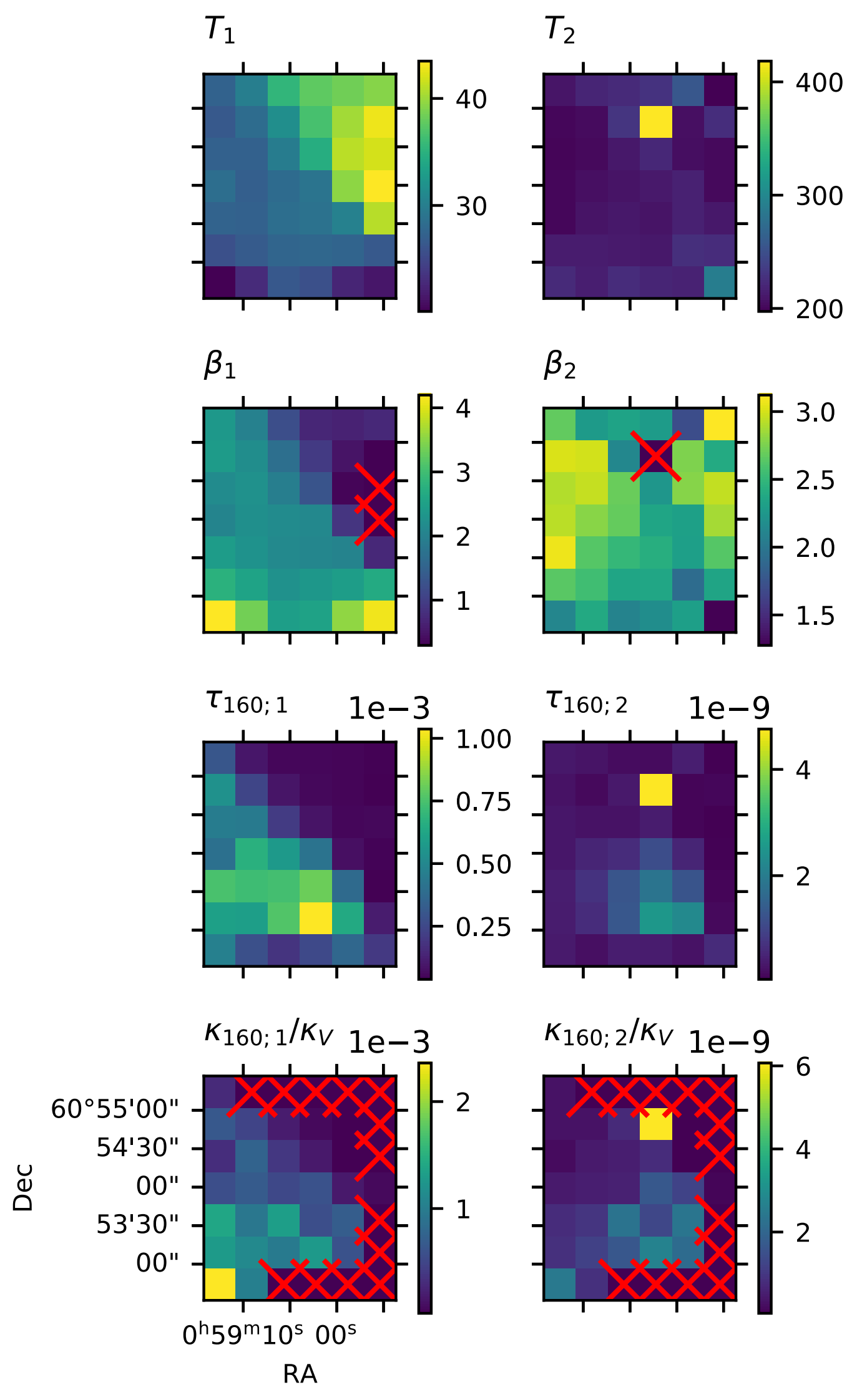
- We reproject the Herschel and Spitzer data onto the map grid
- A(V) correlates with all fluxes
- The slopes shown below provide a measurement of the dust SED per A(V) unit, regardless of the background A(V) or flux
- We find $T_1 = 29.9$ K and $T_2 = 227$ K





Modified blackbody fitting

- We fit a dual modified blackbody, where each component has the shape
$$S_\nu(\lambda) = \tau_{160}\left(\frac{\lambda}{160\,\mu m}\right)^{-\beta} B_\nu(\lambda;T)$$
- We find the parameters shown in the picture on the right for individual pixels
- We combine these fits and the A(V) map to derive the dust cross section ratio
$$\frac{\kappa_{160}}{\kappa_V} = \frac{\tau_{160}}{A_V}$$



Conclusions

- We successfully adapted and used the BEAST to model the background stars of the PDR in IC63.
- For the first time, we have provided a complete, spatially resolved view of the dust within a PDR.
- The values for T_1 and $\tau_{160;1}$ correspond well to values found in the literature (Andrews et al. 2018), which validates our approach.
- R(V) decreases along the axis of the radiation field. This means that the average dust grain is larger at the front of the nebula, and points to the existence of dust evolution processes that change the grain size distribution. Additionally, we find variations in the ratio κ_{160} / κ_V.

Acknowledgements

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The BEAST on GitHub:
www.github.com/BEAST-fitting/BEAST