

PAH Properties Along the Metallicity Gradient of M101

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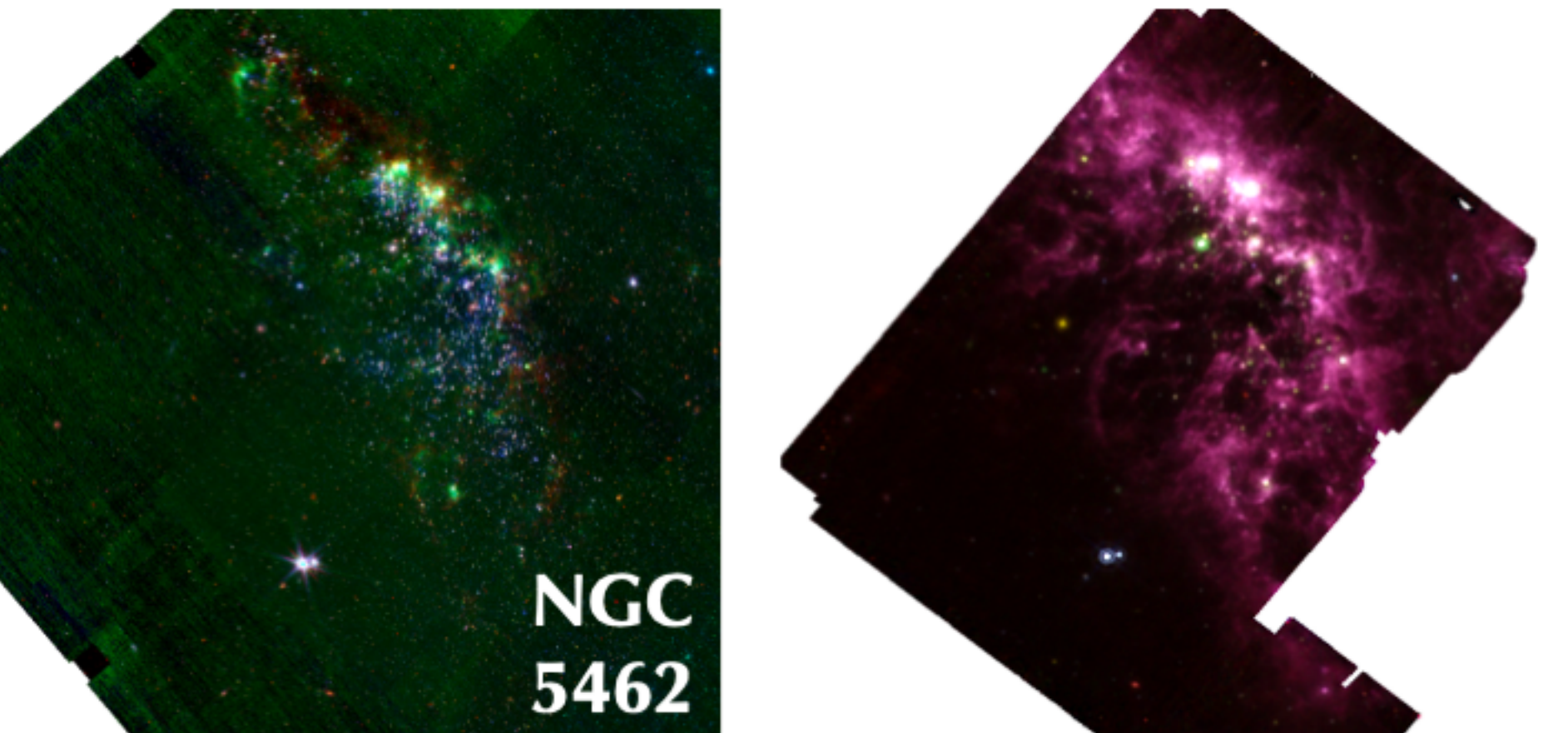
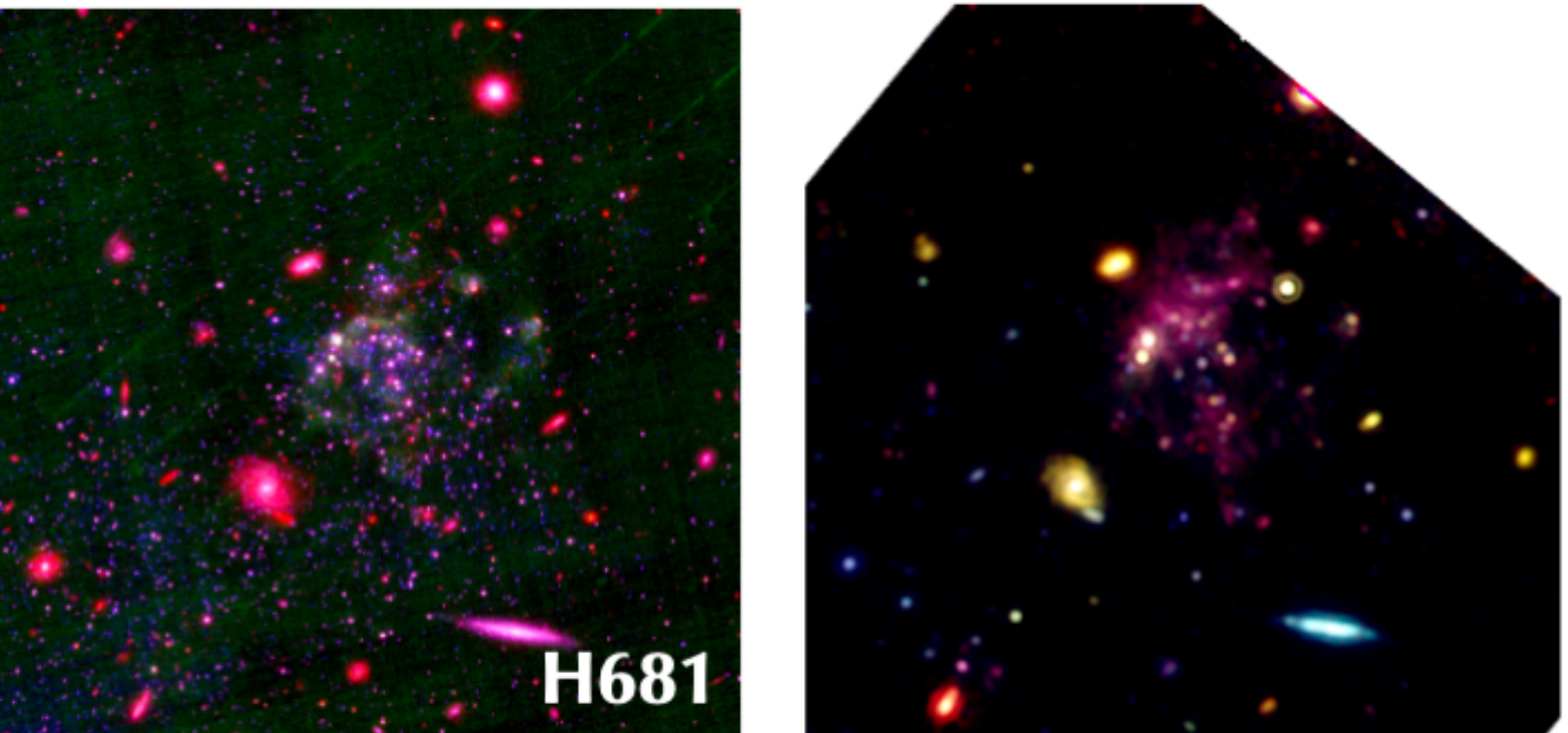
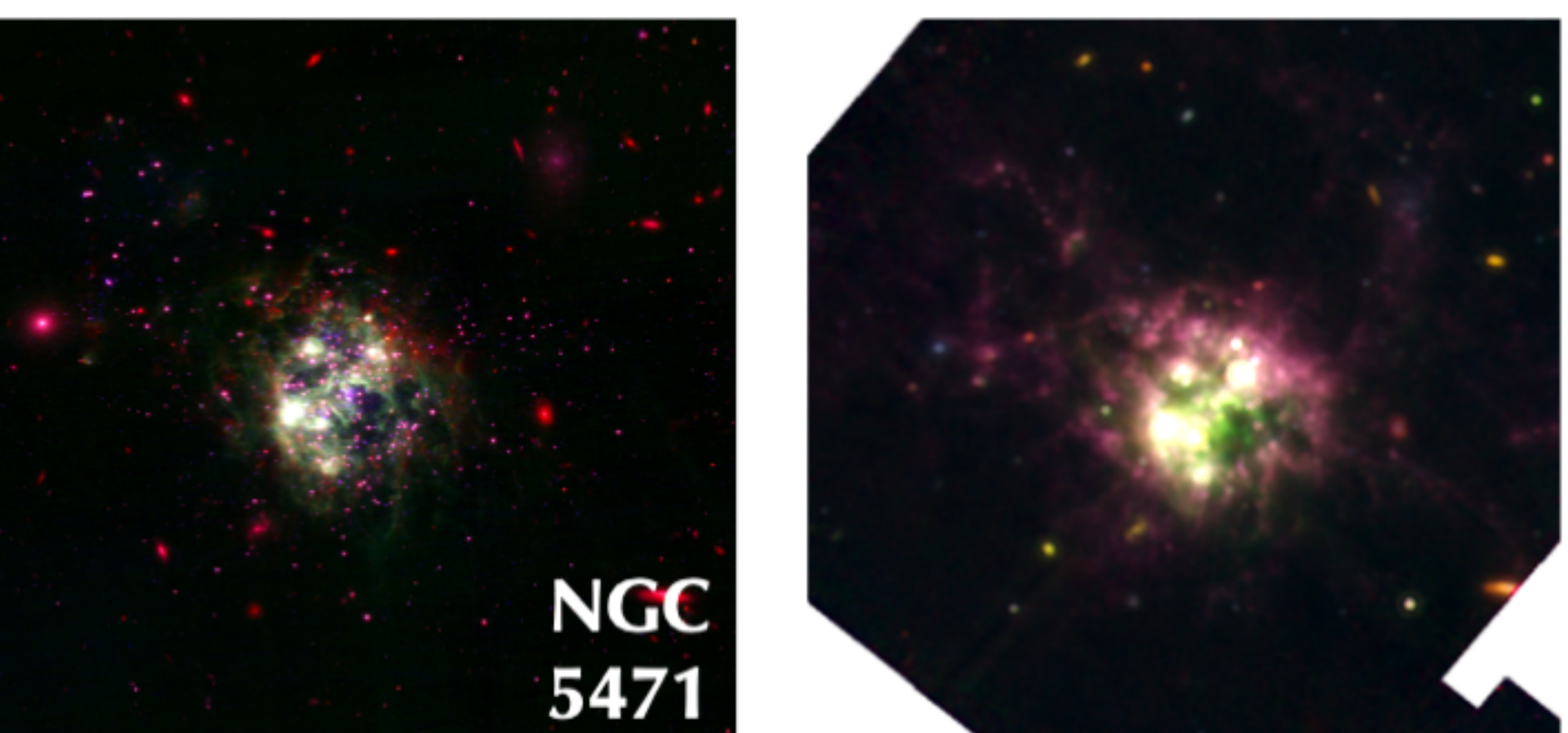


Motivations and Program Summary

The abundance, properties, and feature emission strength of polycyclic aromatic hydrocarbons (PAHs) varies strongly with metallicity. Below 0.2 $Z_{\odot}$, PAH abundance (relative to total dust mass) declines steeply, with differences in shielding, grain growth, ISM density, and UV field strength all proposed to cause this decline. To understand the co-varying effects of environment on PAH emission and feature ratios, we present early results from a comprehensive JWST imaging program towards the nearby ($D \sim 6.7$ Mpc), data-rich spiral galaxy M101.

The full program includes 6 fields with metallicities ranging from $\sim 0.15 - 1 \times Z_{\odot}$ (see table) and span span 1.6 – 3 dex in neutral / ionized gas density and UV field strength. This poster focuses on 3 representative fields (NGC 5462, NGC 5471, and H681). The nucleus and NGC 5455 fields are supplemented by data from GO 2452 (PI JD Smith).

From GO 3429 (PI C. Clark), we have 11 JWST/NIRCam and MIRI filters: F090W, F187N, F200W, F300M, F335M, F360M, F444W, F770W, F1000W, F1130W, F2100W

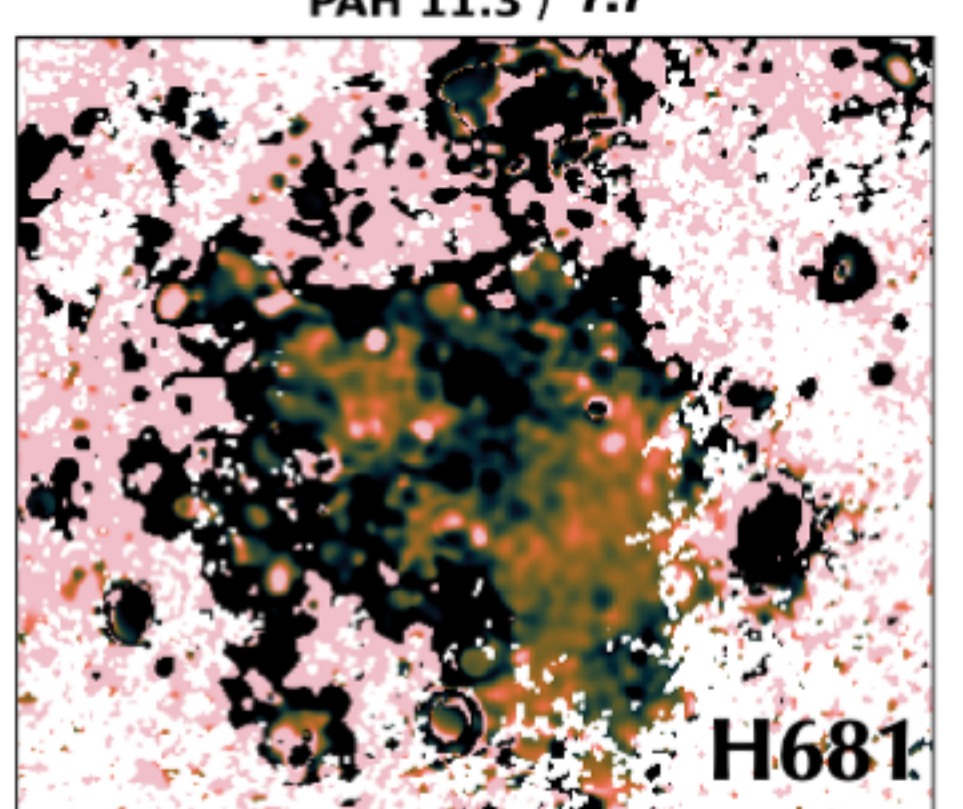
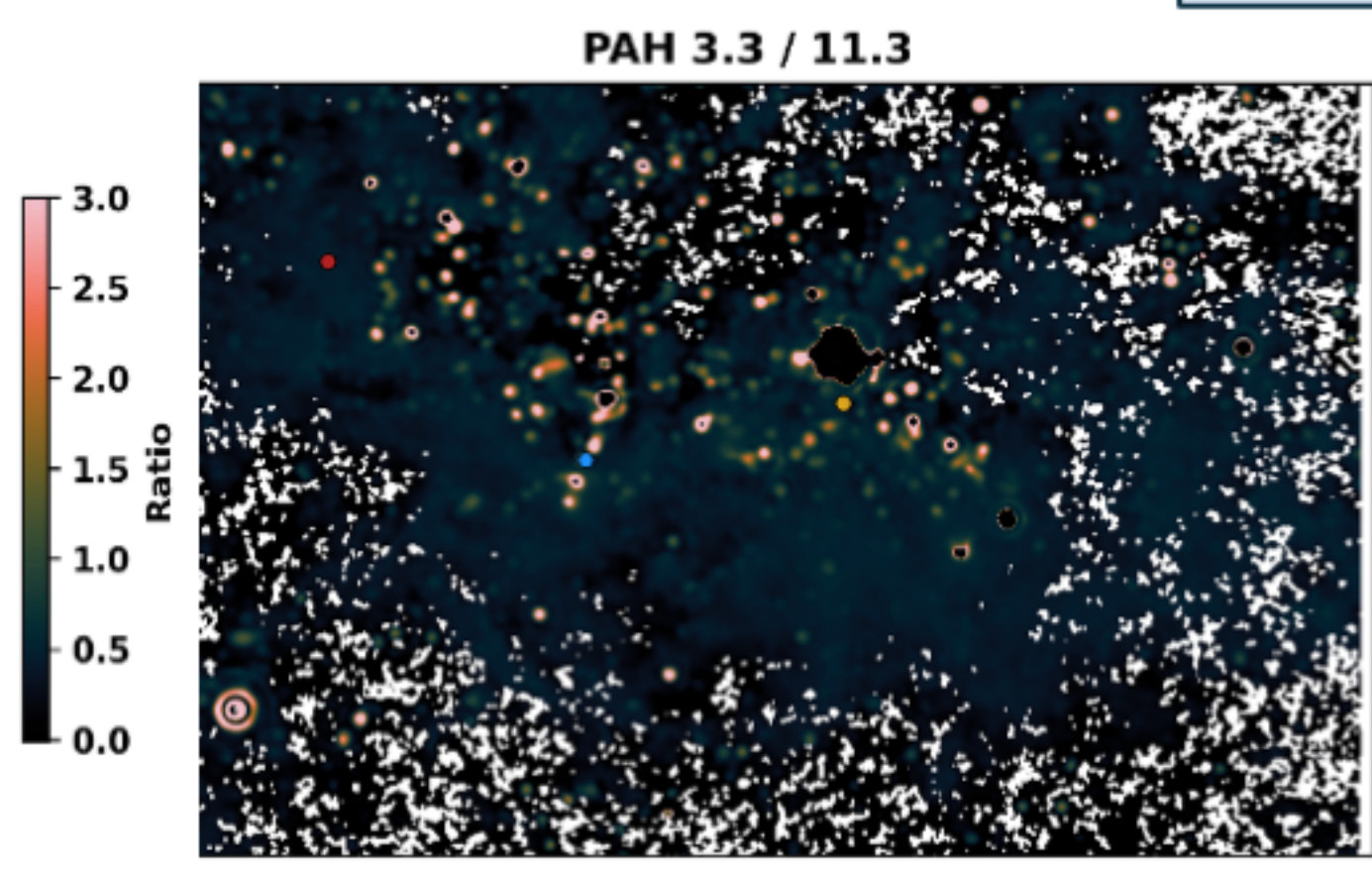
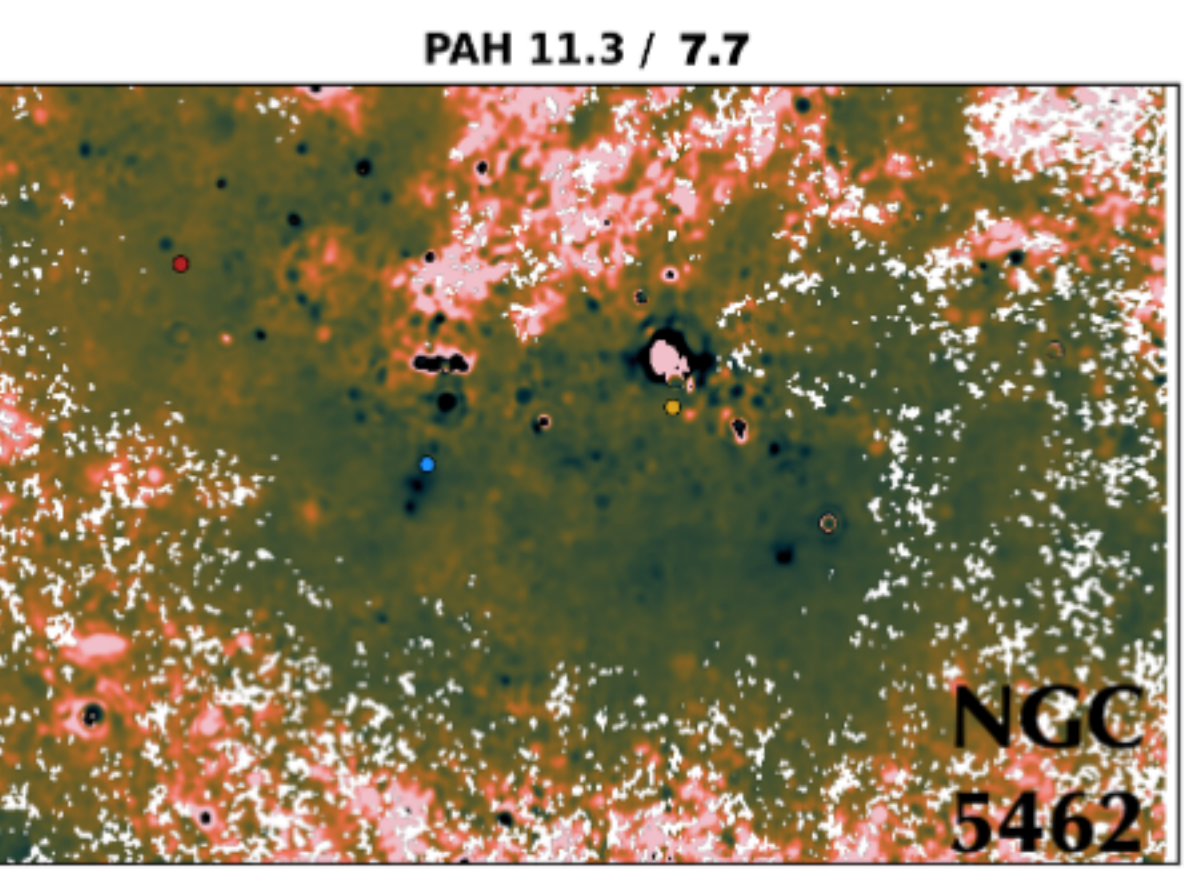


Field	$12 + \log(\text{O}/\text{H})$
Nucleus+H602	8.78
NGC 5462	8.51
NGC 5455	8.39
NGC 5471	8.16
H27 & H67	7.95 & 8.24
H681	7.87

[1] RGB zoom-in images of 3 representative fields (NIRCam F335M / F187N / F090W at F444W res. on left; MIRI F1130W / F1000W / F770W at F2100W res. on right).

What you should take away:

- Faint but significant PAH emission even in the lowest-Z field, with little (significant) spatial overlap between ionized gas and $3.3 \mu\text{m}$ ($7.7/11.3 \mu\text{m}$) features
- $\sim$ Uniform feature ratios at $Z_{\odot}$
- Giant HII region NGC 5471 either has hot dust excess or no PAH emission at center; what are the physical implications?



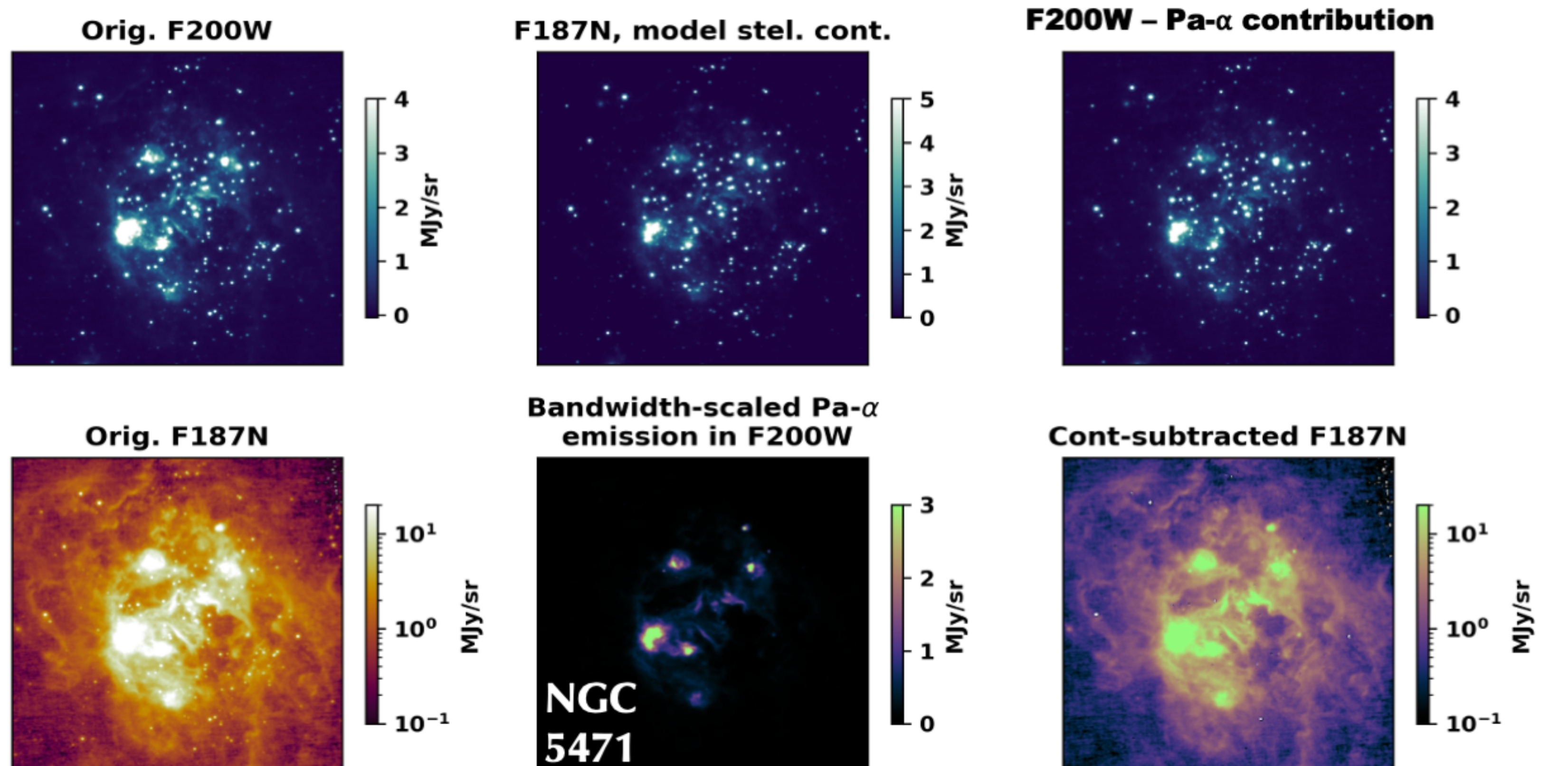
[3] Continuum-subtracted PAH feature ratios for NGC 5462 and H681. Point-like residuals generally correspond to bright stars; white pixels were skipped in the fitting (usually due to lack of reliable F444W_{dust}).

Continuum modeling and Feature Isolation

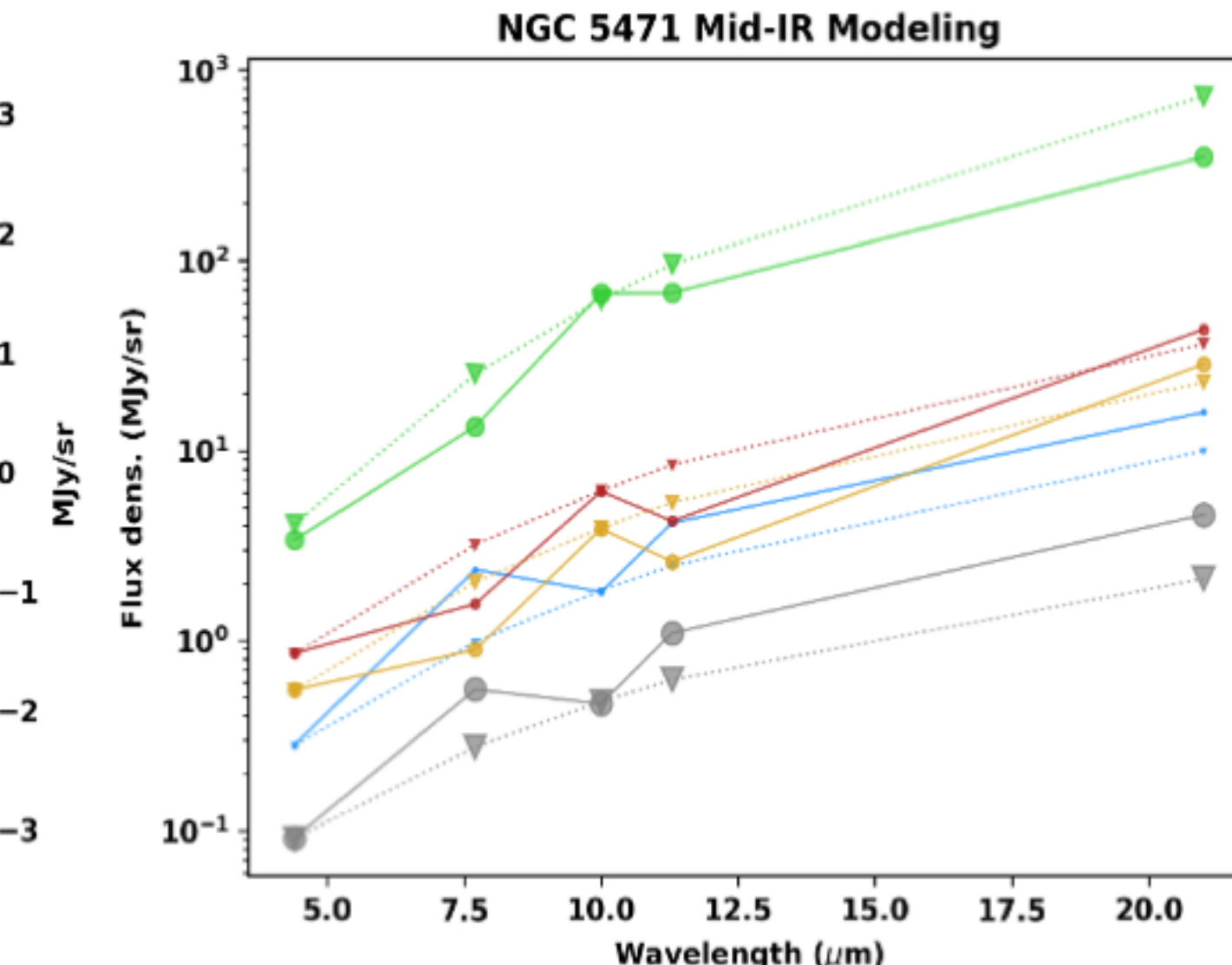
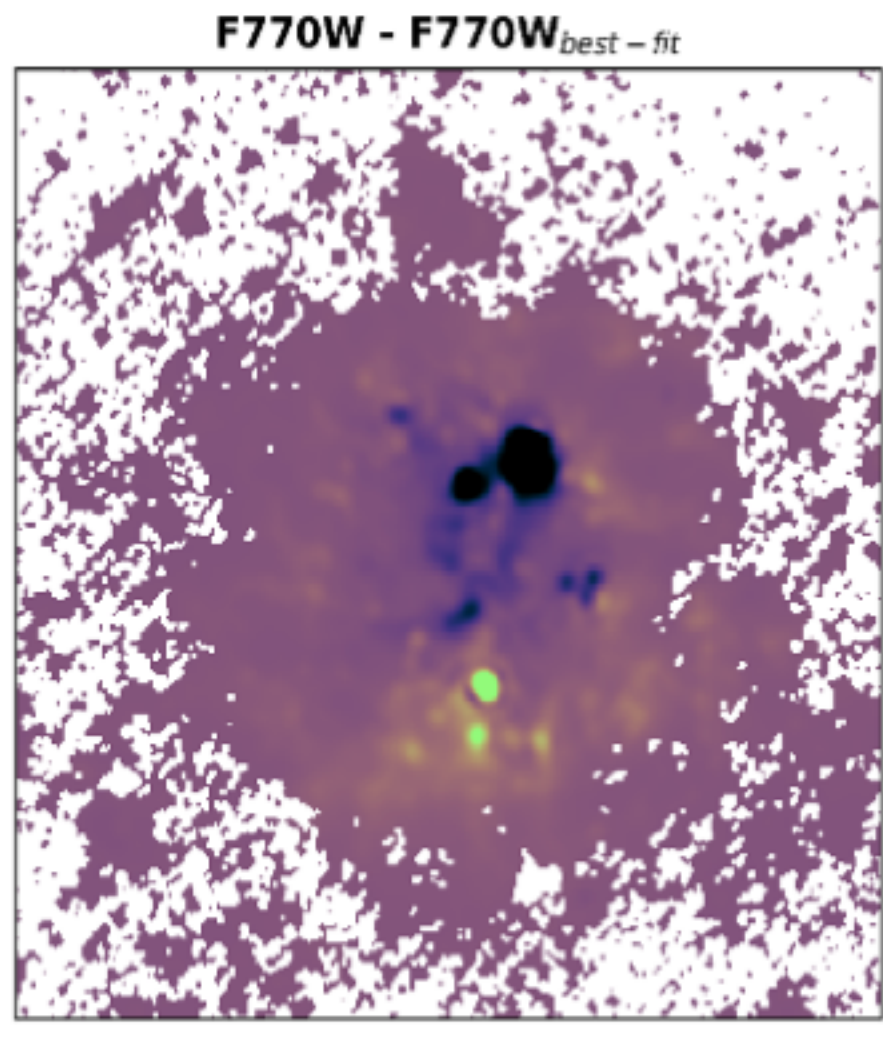
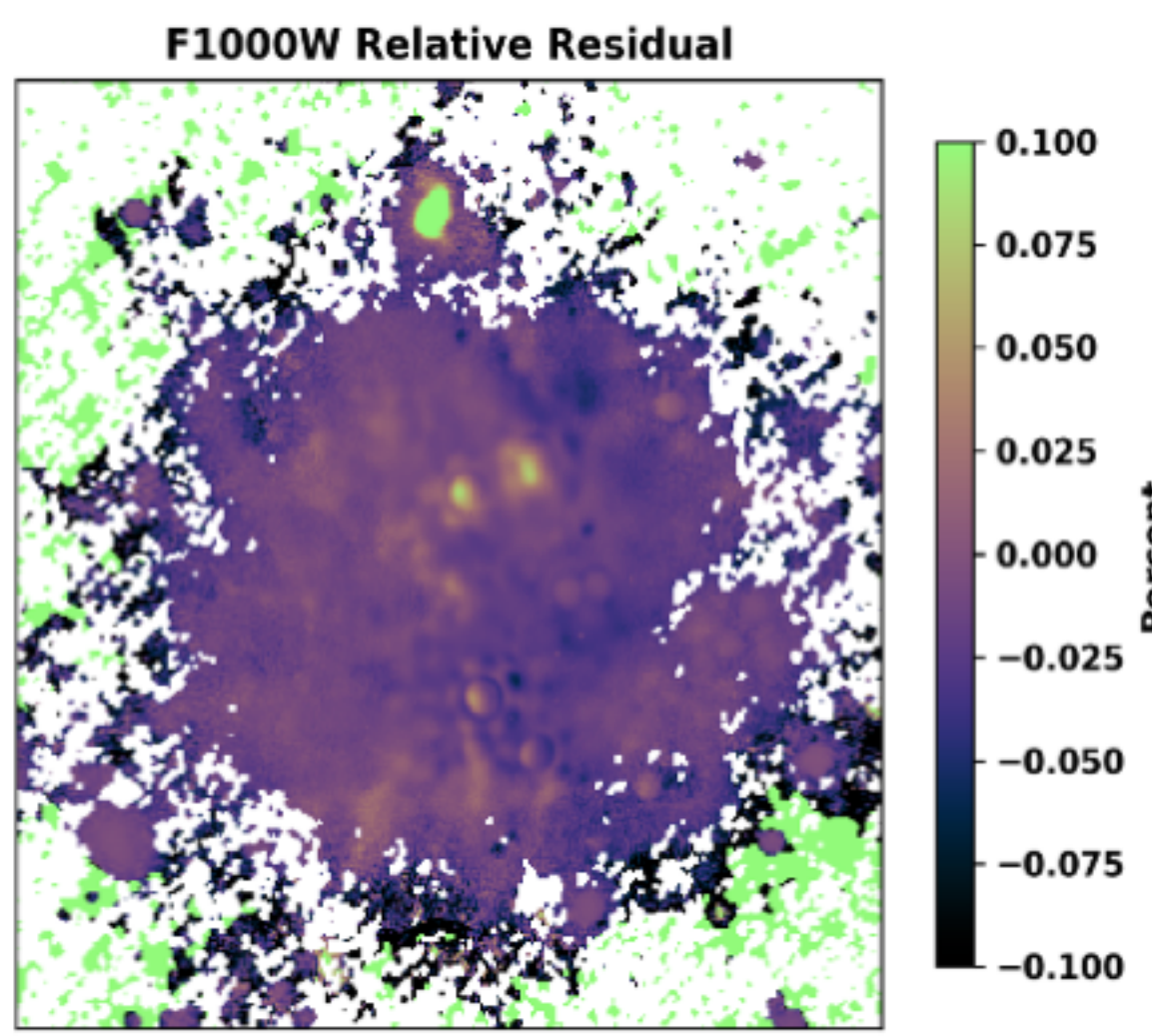
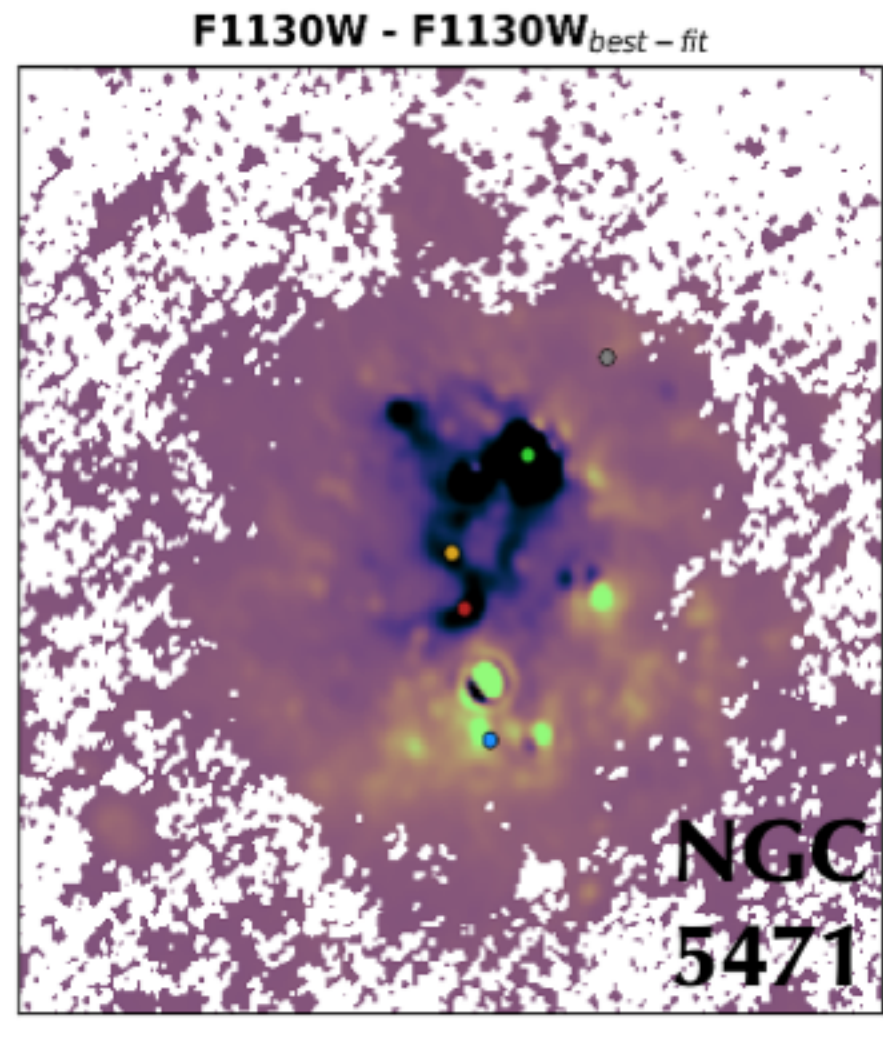
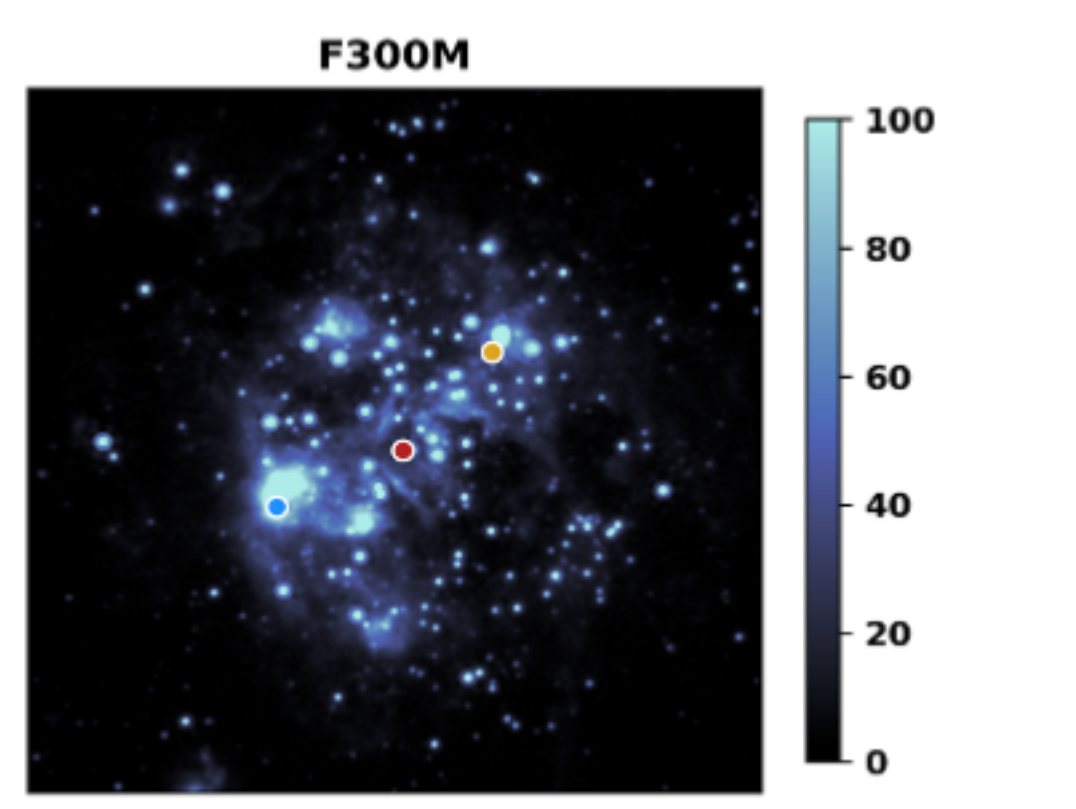
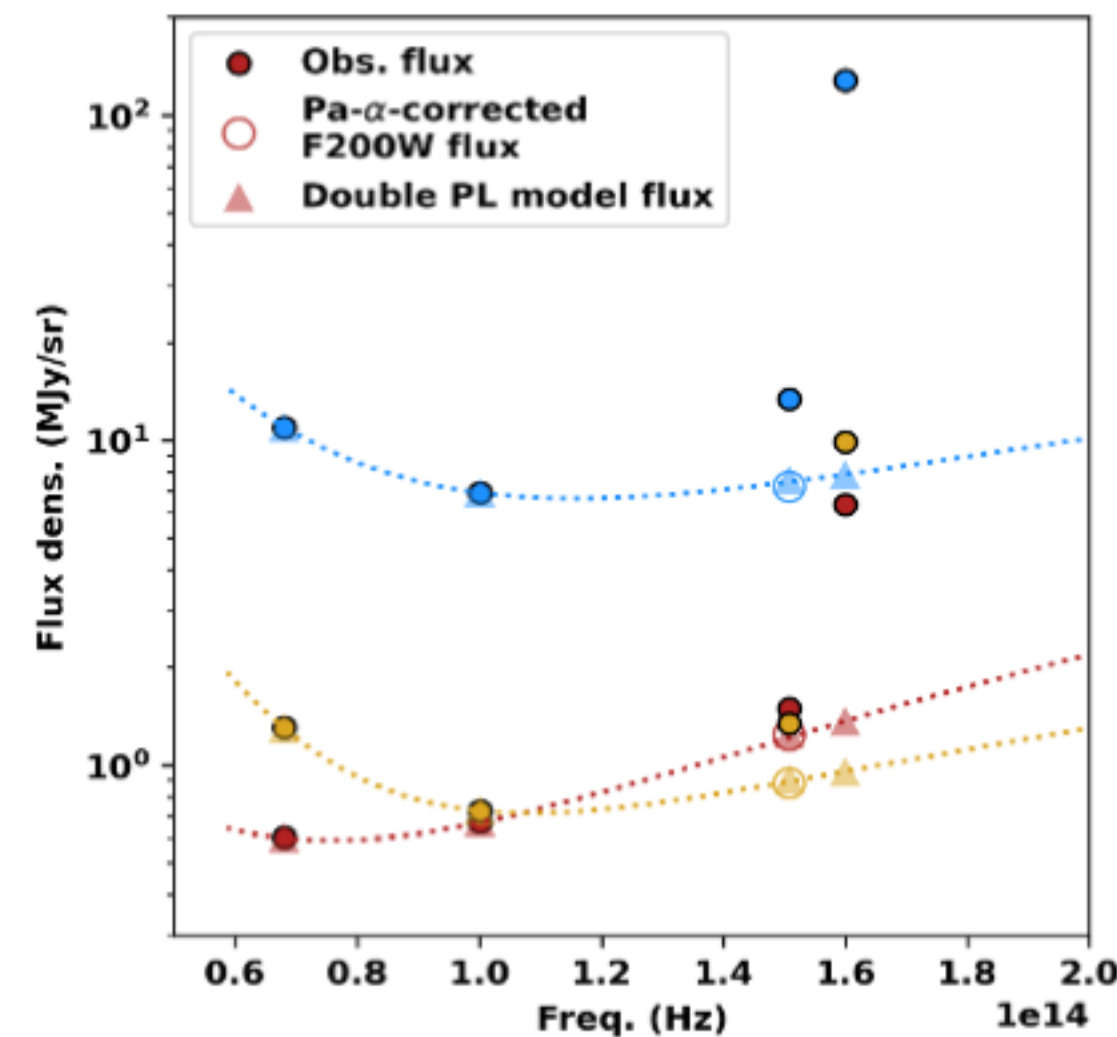
If interested in the data reduction, please come chat!

NIR continuum: We model the combined NIR stellar+dust continuum using an iterative, double-power law fit to F200W, F300M, and F444W. Each iteration creates a continuum-subtracted Pa- α map, which we scale and subtract from F200W before the next iteration (cf. Gregg+ 2024; max 4 iterations needed). Visual example of the Pa- α correction shown in Figure [2]. All NIRCams data are convolved and re-gridded to each field's F444W image.

MIR continuum: With the stellar component of F444W subtracted, we model the MIR dust continuum with a single power law fit to the F444W dust component, F1000W, and F2100W. This fails for some areas around bright stars and ultra-young star clusters, esp. in NGC 5471. All data are convolved and re-gridded to each field's F2100W image.



[2] Illustration of our NIR continuum subtraction method after 2 iterations in NGC 5471. **Top:** Original F200W and F187N data (left), intermediate products (center), and output Pa- α map and Pa- α -corrected F200W (right). **Bottom:** Pixel-level empirical SEDs and best-fit models from the 2nd continuum fitting iteration.



[4] Illustration of breakdown of mid-IR modeling in NGC 5471. Excess in F1000W and/or F2100W cause single power-law fits to overpredict F770W and F1130W in filamentary structures.

To-do List and Outstanding Questions

- What's happening with the dust continuum in NGC 5471?
- Application of Draine & Li models to the F2100W and/or GALEX-resolution PAH ratio maps
- More data:** New Swift/UVOT far-UV and near-UV observations of M101's northern half (PI C. Clark)
 - Combined with deep archival Swift imaging, this completes the map of UV emission in M101 at better resolution than GALEX
- Even more data:** NOEMA CO(1-0) data at 100 pc resolution of 2 subsolar fields (NGC 5471 & H27+H67; PI L. Jones)
 - Testing the interwoven relations between PAH properties, mol. gas fraction, α_{CO} , UV field, etc