



# Characterizing Structures of the Dusty ISM in Nearby Galaxies



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## • Goal:

- Quantify the fractal geometry of the interstellar medium (ISM) in nearby star-forming galaxies via wavelet power-spectrum analysis.

## • Motivation:

- Theory predicts turbulent regions (e.g., star forming regions) to exhibit fractal dimensions  $\sim 2.5$ ; deviations hint at different physical processes.
- Wavelet image decomposition results in a wavelet power spectrum, the slope of which is a proxy for fractal dimension.

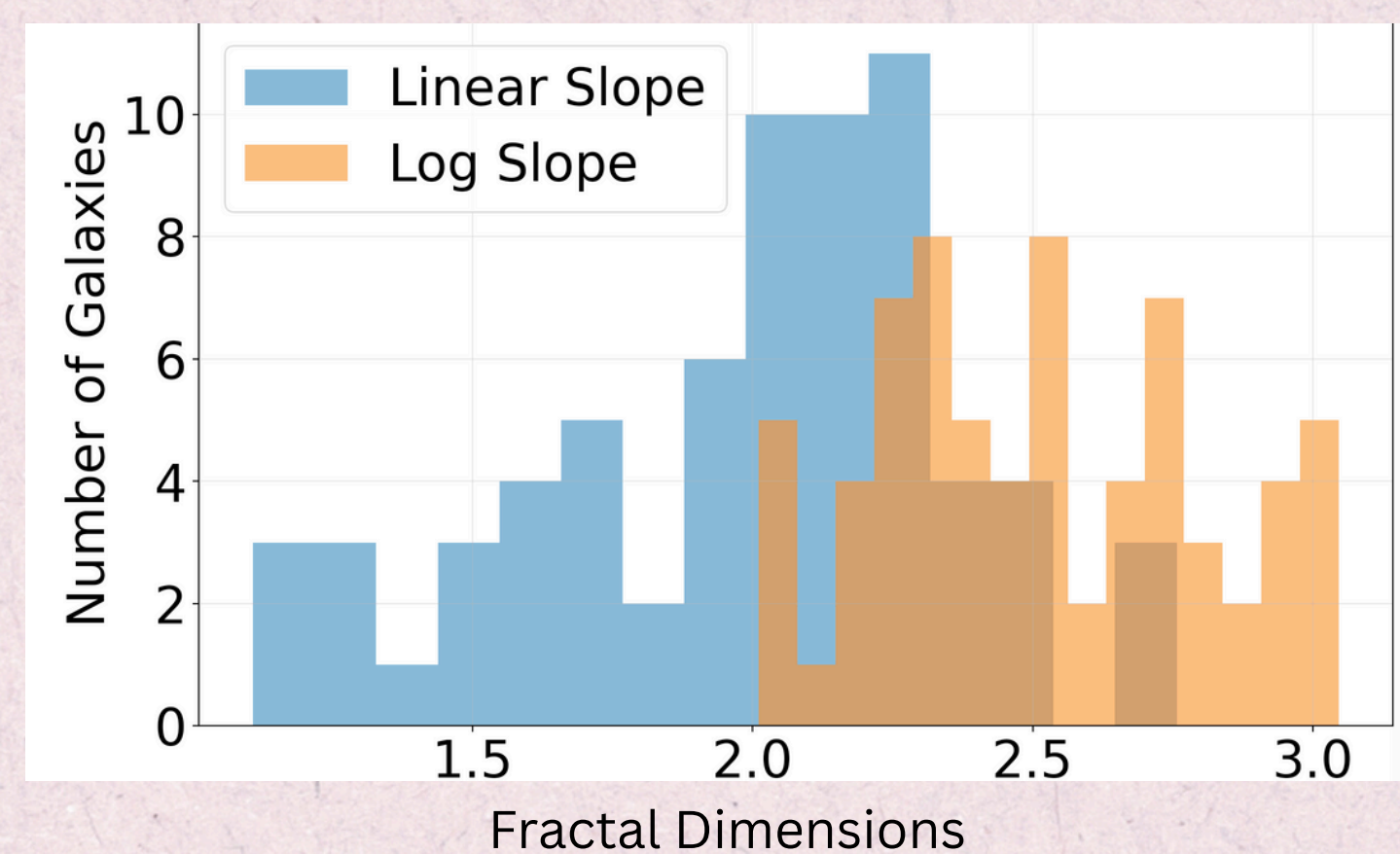
## • Data:

- JWST MIRI F770W images from the PHANGS (Physics at High Angular resolution in Nearby GalaxieS) survey of local star-forming galaxies.
- F770W filter measures dust emission at  $7.7\ \mu\text{m}$  that traces star formation in the ISM.

### What is a Fractal Dimension?

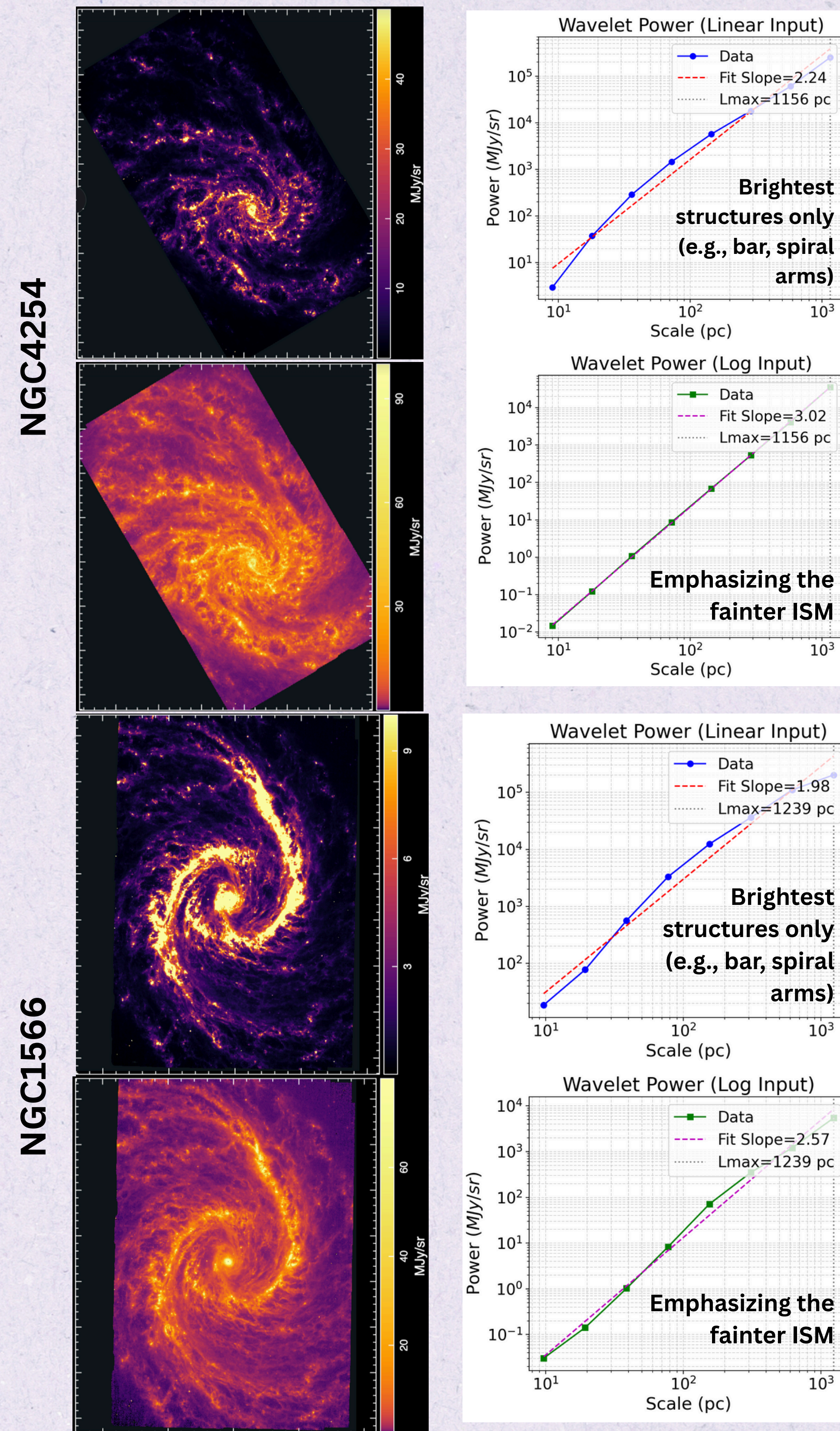
A numerical measure of the complexity of geometrical shapes that are self-similar as you zoom in across scales. These shapes cannot be defined by integer dimensions.

Distribution of Fractal Dimensions (slope of wavelet power spectrum)

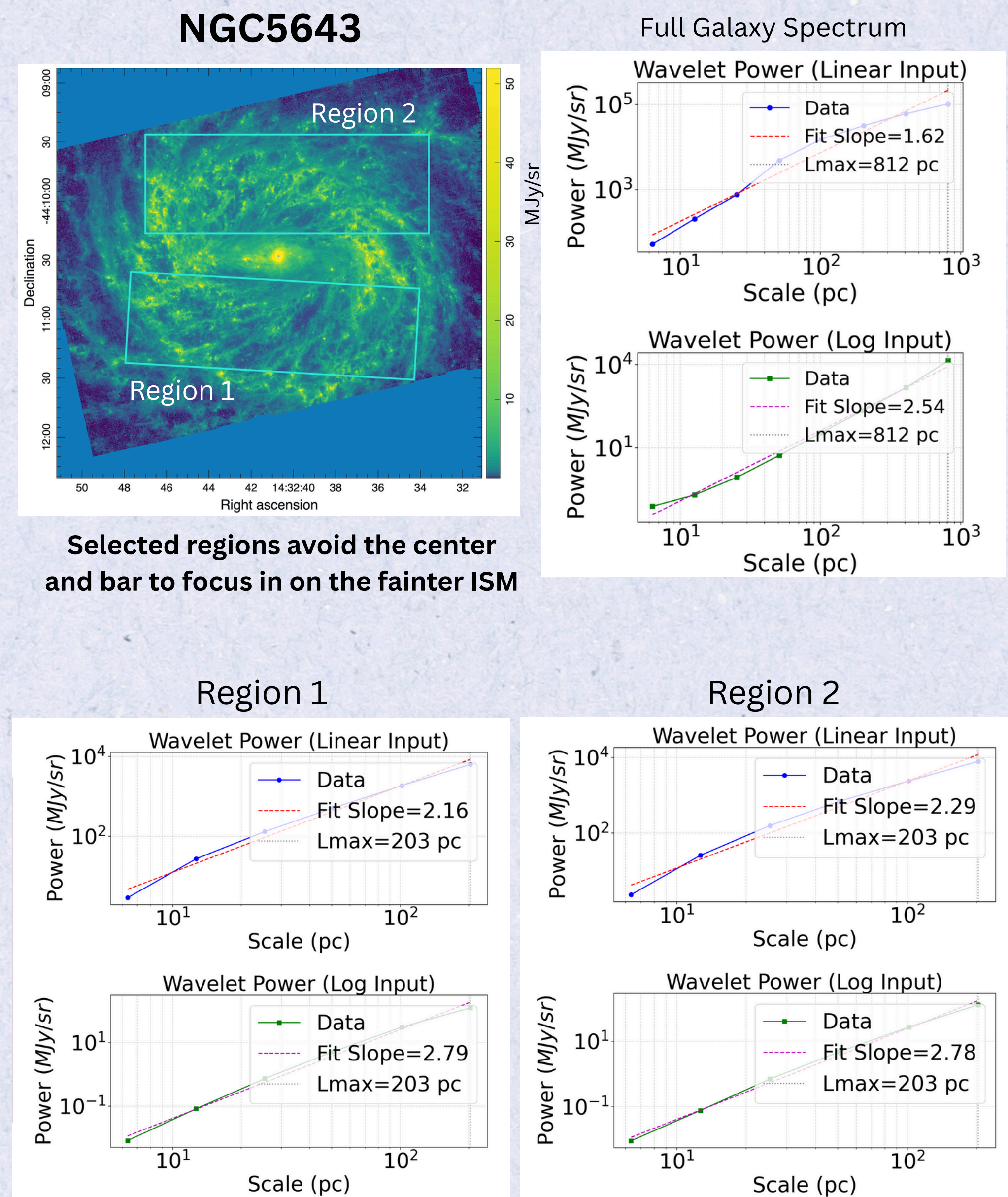


- Distribution of wavelet-derived power spectrum slopes for the PHANGS-JWST images. The blue bars show slopes fitted to linear data and the orange bars those to log data. We find a range of fractal dimensions between  $\sim 1$ -3.

### How does the algorithm work when emphasizing different structures?



### How does the fractal dimension change when we focus on the ISM and exclude the bar and center?



### Conclusions

- Our measurements reveal that the apparent fractal dimension shifts when we adjust image stretching and isolate bright vs. fainter emission sources.
- Future work:** Extend this wavelet analysis across multiple regions and wavelengths to pinpoint the physical processes shaping these patterns.

### References

- PHANGS Collaboration JWST Data Release (2025) <https://sites.google.com/view/phangs/home>
- Elmegreen, B. G., & Falgarone, E. 1996, ApJ, 471, 816–821.
- Torrence, C., & Compo, G. P., 1998, Bulletin of the American Meteorological Society, 79(1), 61–78.
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