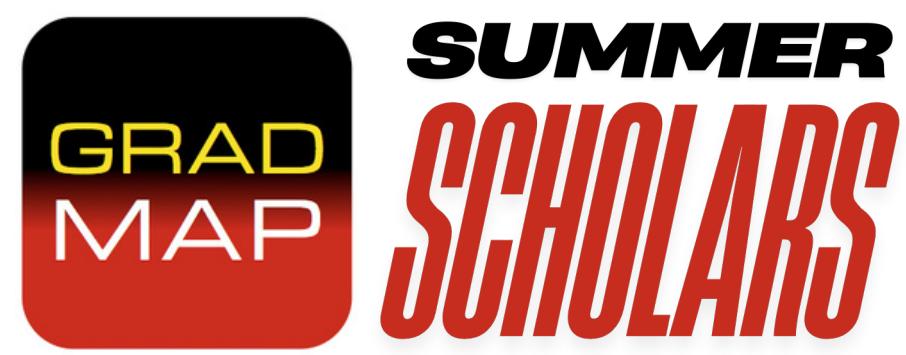




Characterizing Structures of the Dusty ISM in Nearby Galaxies

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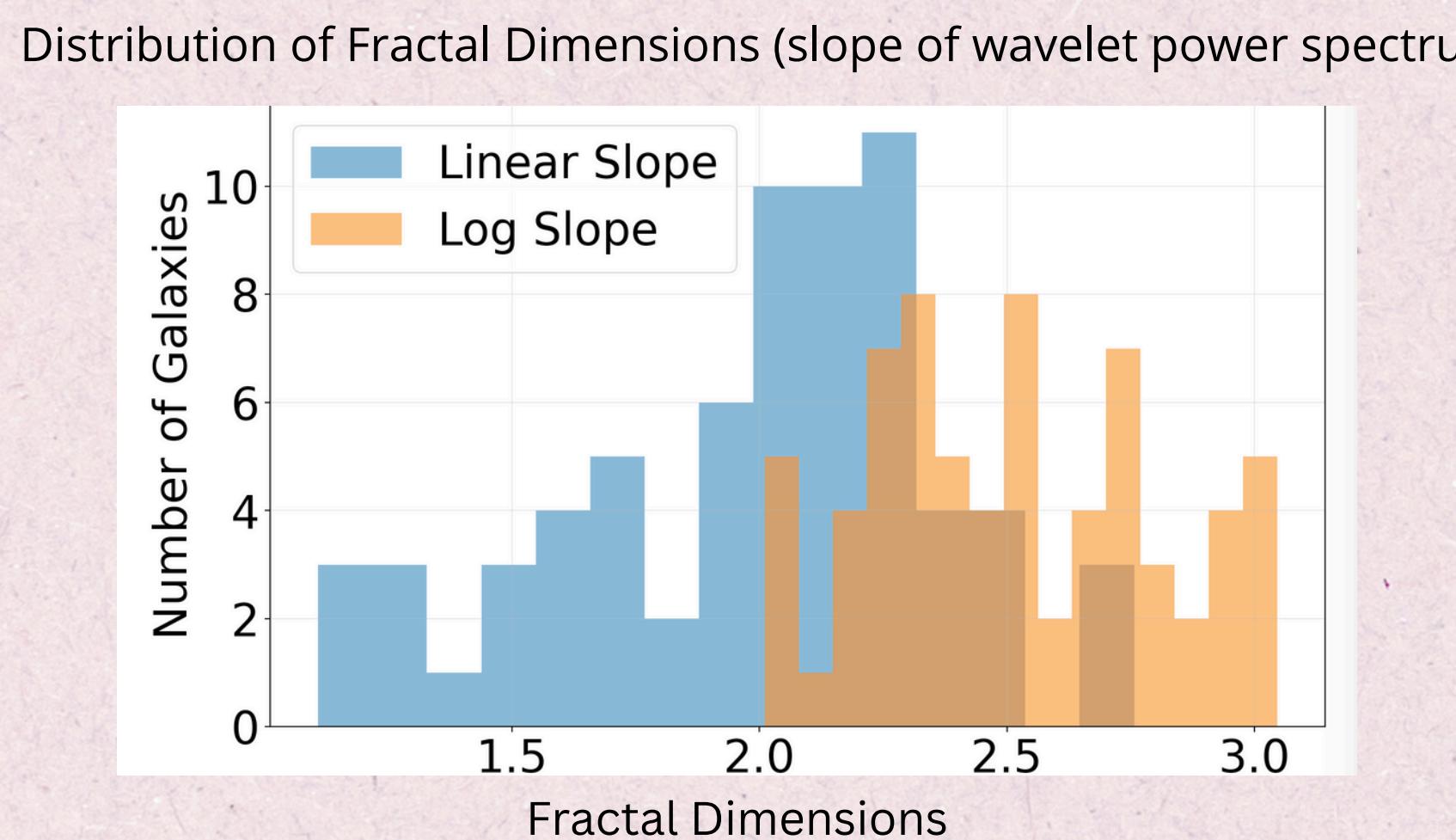
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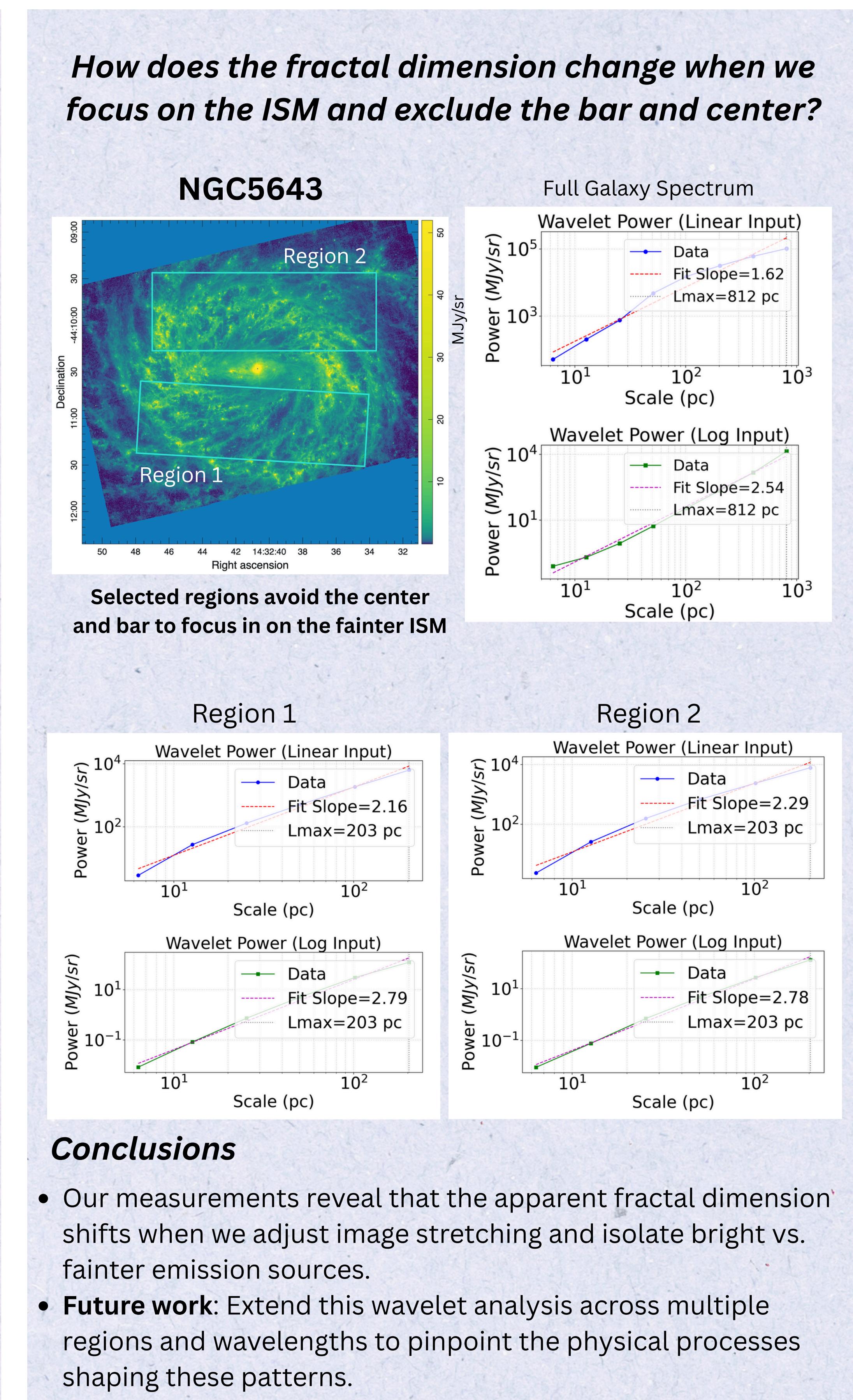
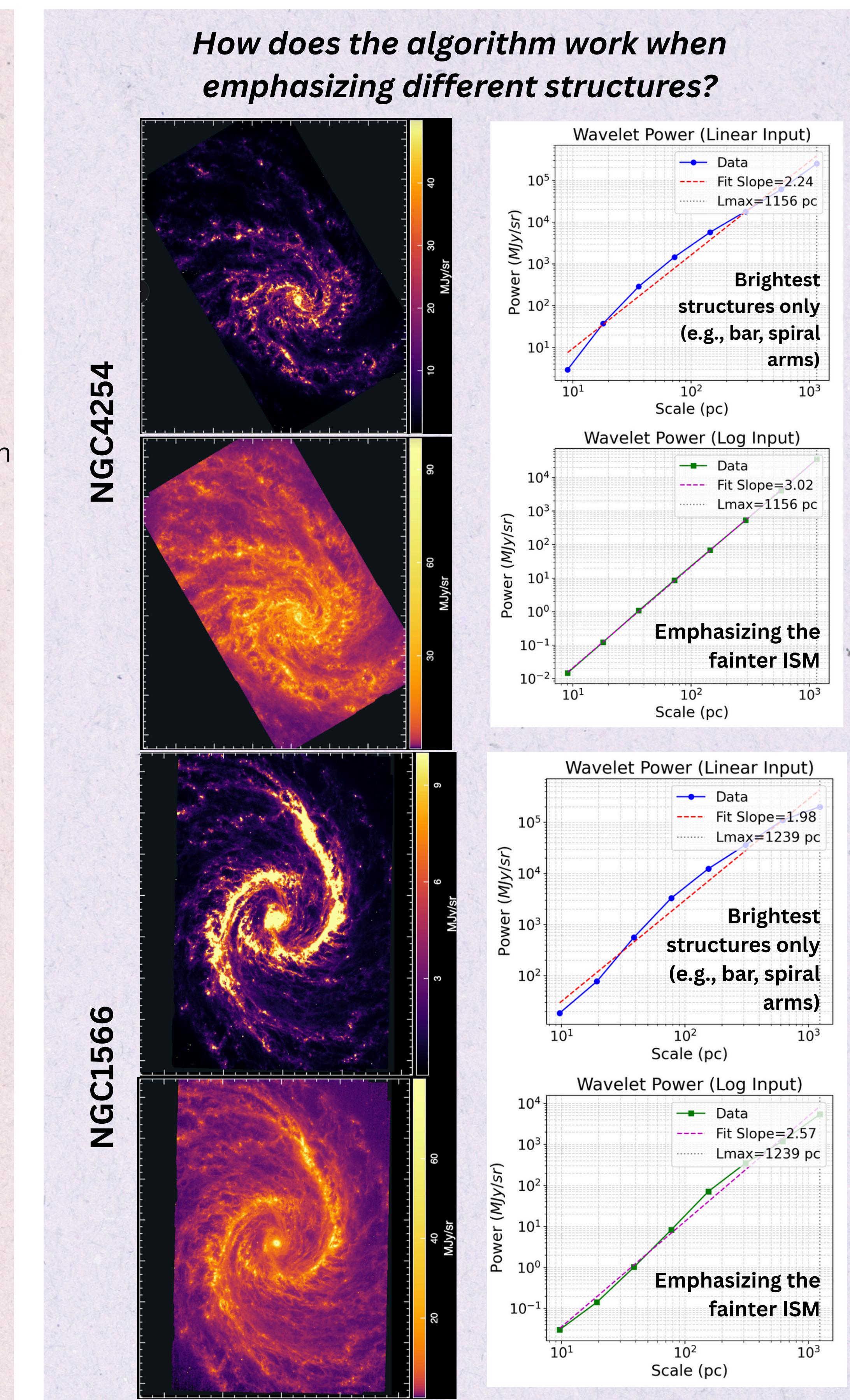
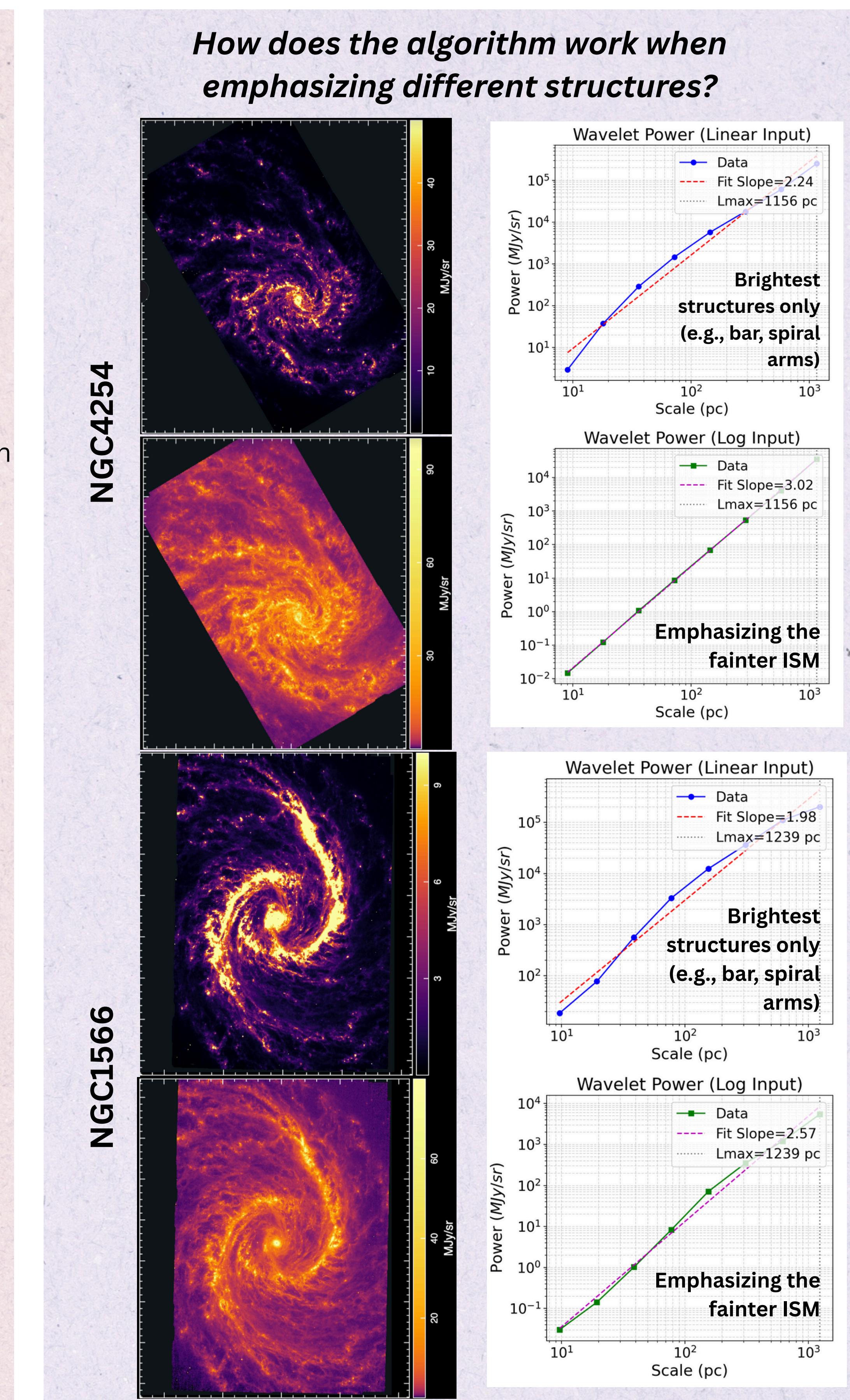
- Goal:**
 - Quantify the fractal geometry of the interstellar medium (ISM) in nearby star-forming galaxies via wavelet power-spectrum analysis.
- Motivation:**
 - Theory predicts turbulent regions (e.g., star forming regions) to exhibit fractal dimensions ~ 2.5 ; deviations hint at different physical 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 GalaxyS) 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 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 $\sim 1-3$.



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.

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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.
- Mayaboroda & Spergel (2025), 10.48550/arXiv.2503.23202



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