FLEX Fourier+Laguerre EXpansions

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Ganapathy et al. (2025)

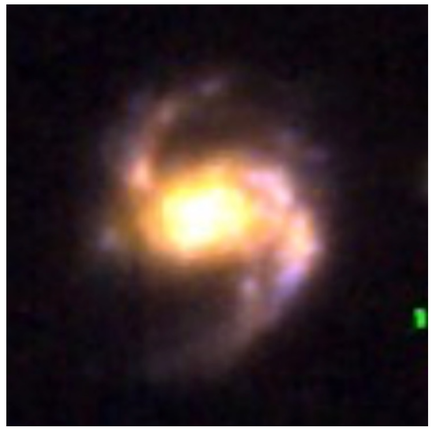


Figure 1. Image of EGS13670, at redshift 2, with $110^2 = 12100$ pixels.

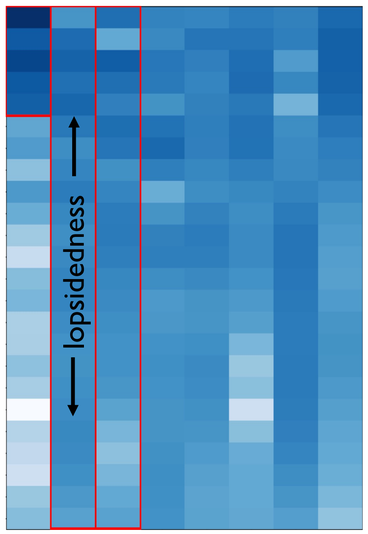


Figure 2. Expansion matrix for EGS13670 in the F115W band with 8x20=160 pixels. Rows encode radial spatial structure, capturing finer structure towards the bottom, while columns encode azimuthal symmetry, with increasing multiplicity from left to right. The compression factor is 75x for this representation of the galaxy, with no real loss of information.

FLEX is a basis function expansion tool to quantify structure in observed galaxies. In a recent publication, we applied FLEX to a sample of JWST galaxies (Figure 1) to create a compressed representation of the galaxy structure (Figure 2). By computing the expansion for a suite of galaxies (Figure 3), we discovered a subtle trend of increasing star formation with increasing disc lopsidedness in the rest-frame optical (Figure 4), with no detectable dependence on redshift (Figure 5). This trend would not have been recovered using conventional metrics for quantifying lopsidedness.

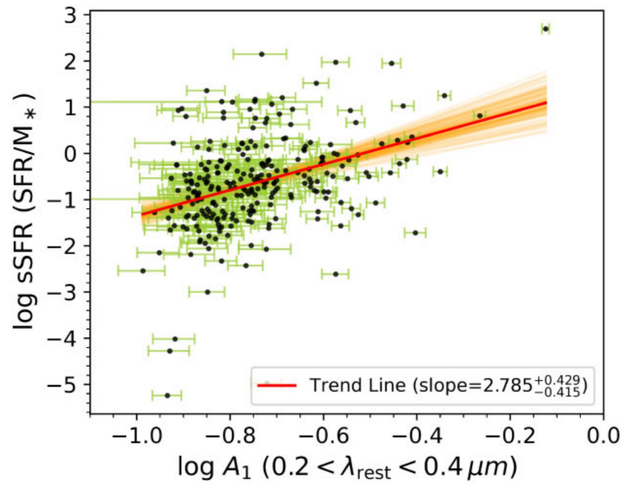


Figure 4. Disc lopsidedness in the restframe near-UV increases with increasing specific star formation rate: detectable owing to the power of FLEX.

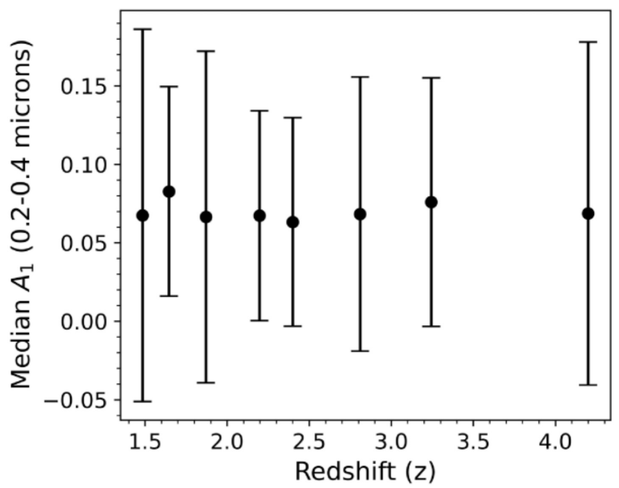
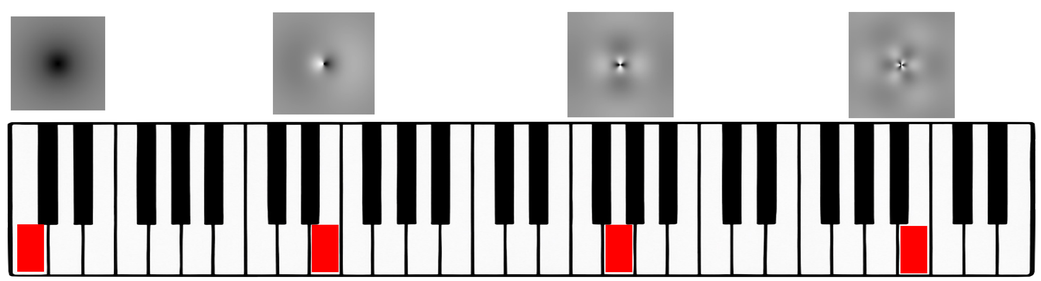


Figure 5. Disc asymmetry (non)evolution with redshift. Surprisingly, even during cosmic noon, the lopsidedness of disc galaxies is largely constant.

Figure 3. Images (left) and expansion matrices (right) for EGS 22604, EGS 26748, and EGS 18230 (top to bottom). All images have been visual classified as disc galaxies. EGS 26748 (middle) shows clear lopsidedness that FLEX is able to efficiently identify and quantify.



Also, come discuss sonification with us and how to render galaxy images as sounds!

Thanks to the CEERS team for a very straightforward data access pipeline, and to the CANDELS team for collecting the ancillary data. MP acknowledges support from a UKRI Stephen Hawking Fellowship.