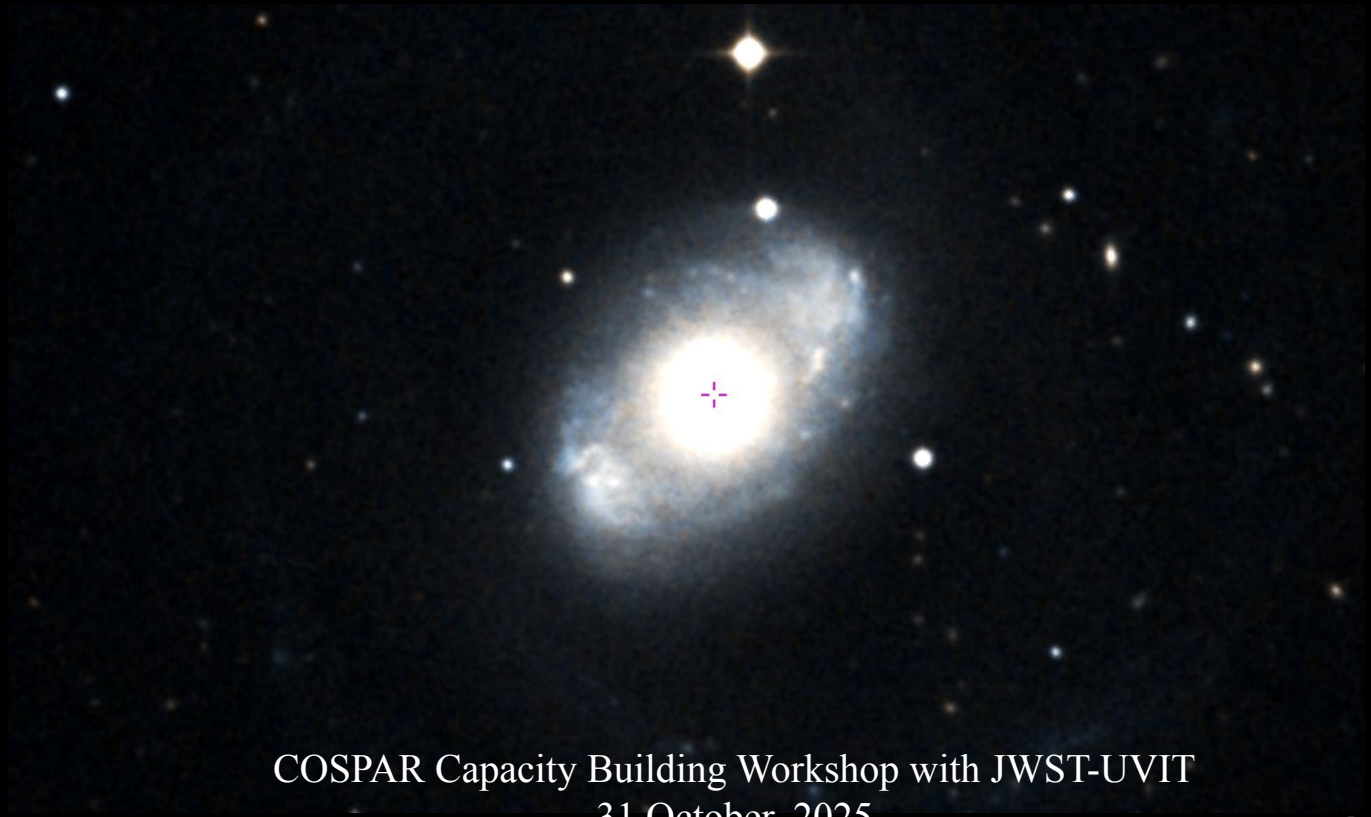
Study of Near IR emission from NGC 4151 with NIRSpec-IFU

- Neal Titus Thomas, Christ University



COSPAR Capacity Building Workshop with JWST-UVIT

31 October, 2025

Image credit: https://sky.esa.int

Source ⟶ NGC 4151

- Barred spiral, Seyfert 1/1.5 Active Galactic Nucleus (AGN) in the constellation Canes Venatici Heckman et al. (1980).
- Distance = 19.1 Mpc Tammann et al. (2008).
- Redshift (z) ≈ 0.0033 (NED).
- Broad-line region (BLR) & narrow-line region (NLR) Peterson et al. (2004).
- The nucleus shows canonical broad-line emission (e.g., broad H β, H α, He II) and narrow-line emission (e.g., [O III] λ5007, [N II], [S II], [O I]) typical of Seyfert 1/1.5 galaxies Bentz et al. (2006).
- The IR emission is strongly dominated by the AGN nucleus in NGC 4151 rather than ordinary star formation Clavel et al. (2000).

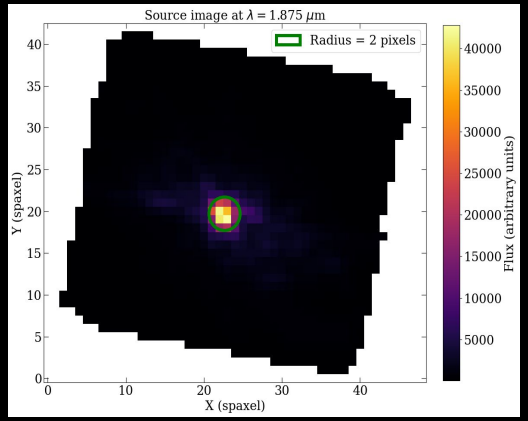
Data ⟶ JWST/NIRSpec IFU

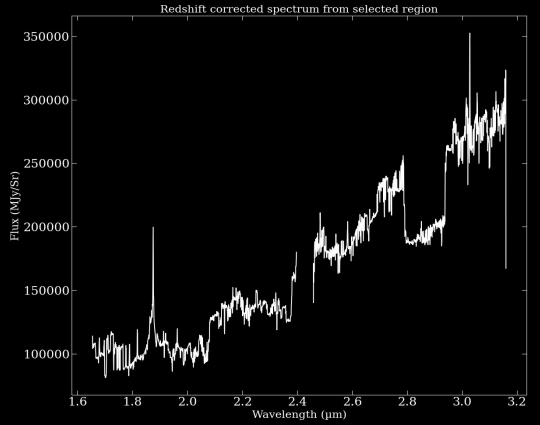
- Date - 09-12-2022
- Exposure time = 11554.401 s
- Grating - G235H
- Filter - F170LP
- Resolving power ~2,700
- Wavelength range = 1.66 – 3.05 μm
- Dither type = Cycling
- Total dithers = 12

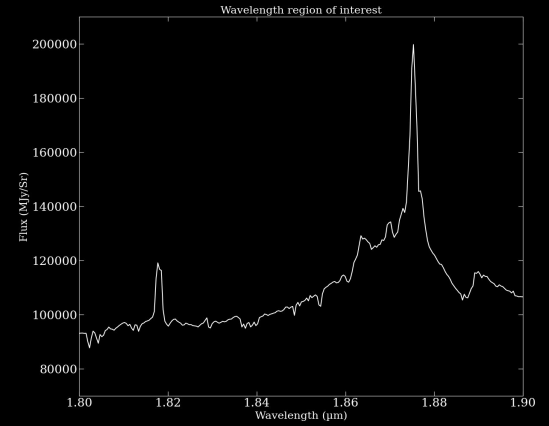
Stage 1b

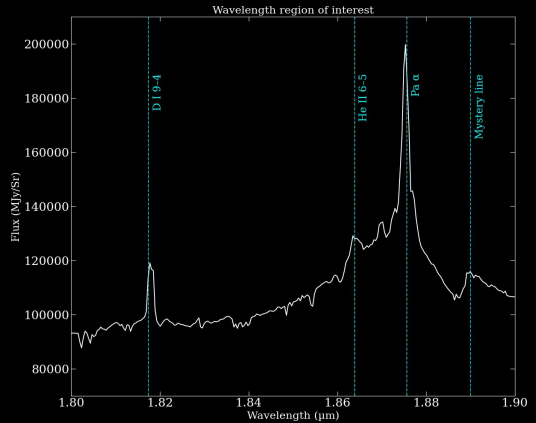
Stage 2 - - - Imprint subtraction

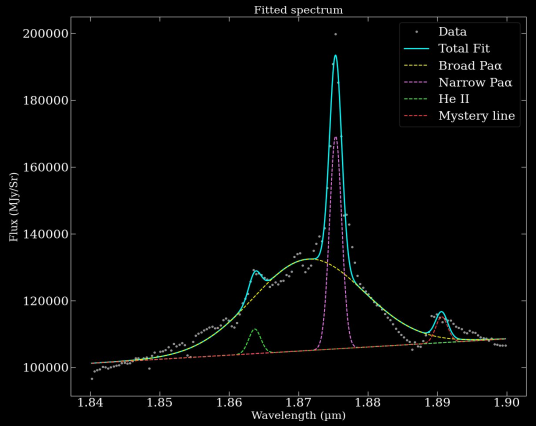
Stage 3











Fit parameters

	Line energy (μm)	Amplitude
Narrow Paα	$\lambda_F = 1.8753 \pm 0.000028$ $\lambda_T = 1.8756 \pm 0.0000045$	63595.0363 ± 1854.1114
Broad Paα	1.8714 ± 0.000264	27343.6334 ± 791.4157
He II	$\lambda_F = 1.8637 \pm 0.000245$ $\lambda_T = 1.8642 \pm 0.000015$	7375.0530 ± 1729.3547

Derived parameters

$FWHM_{\text{Narrow line}} = 327.8 \pm 11.5$ km/s

$FWHM_{\text{Broad line}} = 3023.2 \pm 106.7$ km/s

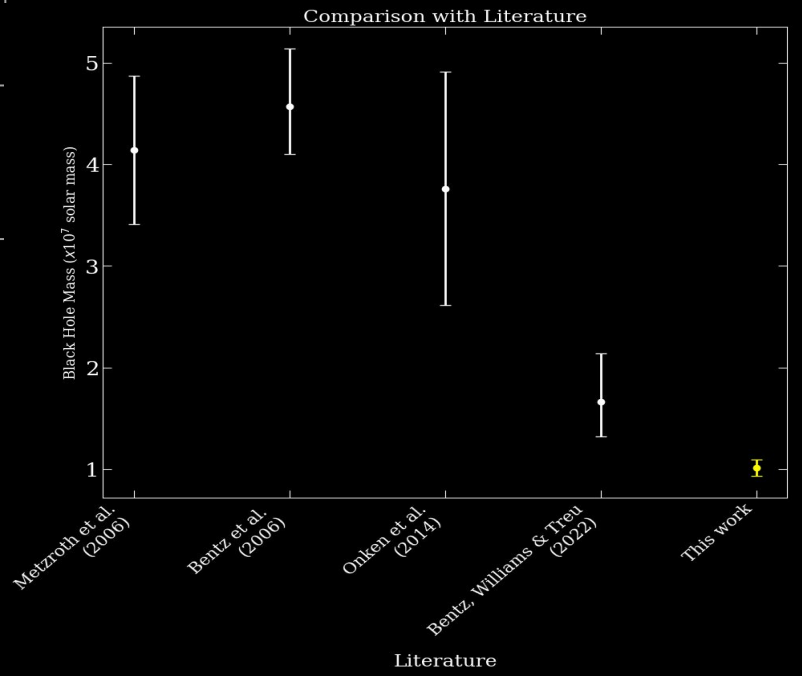
$F_{\text{Paα | broad}} = 1.10 \pm 0.05 \times 10^{-13}$ erg/s/cm²

$L_{\text{Paα | broad}} = 4.82 \pm 0.55 \times 10^{39}$ erg/s

$$M_{\rm BH} = 10^{7.31} \left(\frac{L_{\rm line}}{10^{42}\,{\rm erg\,s^{-1}}}\right)^{0.48} \left(\frac{\rm FWHM}{10^{3}\,{\rm km\,s^{-1}}}\right)^{1.68} M_{\odot}$$

D. Kim et al, 2010

Black hole Mass = 1.01 ± 0.08 x 10^7 $M_\odot$!!!



References

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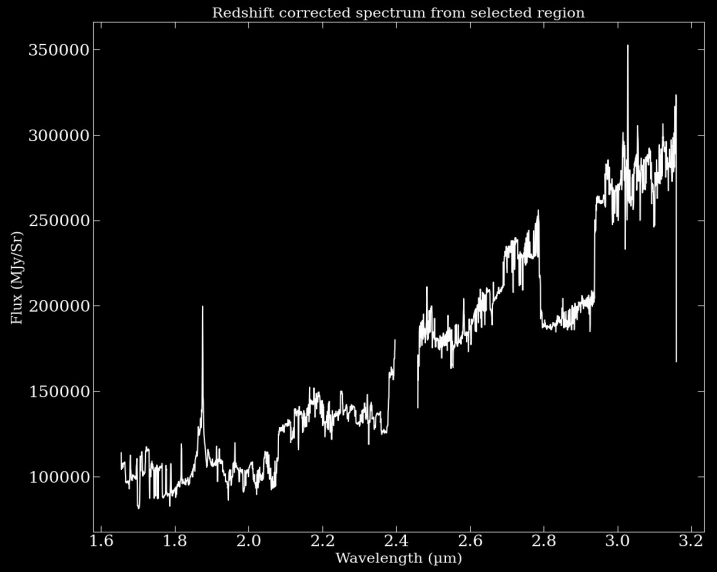
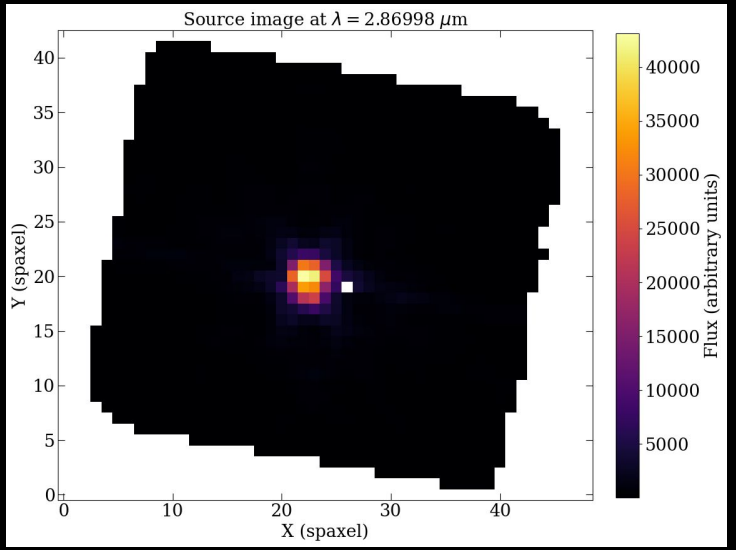
- Peterson, B. M., Ferrarese, L., Gilbert, K. M., et al., *The Astrophysical Journal*, vol. 613, no. 2, pp. 682–693, 2004.

Thank you

Saturated pixel at λ = 2.86998 - 2.92463





- Possible solution - Re-run Stage 2 Pipeline with spec2dict['pixel_replace']['skip'] = False
- Very time consuming.