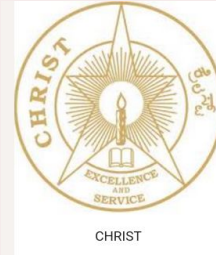


Massive, evolved galaxies at $z > 3$

Presentation by: Renu Devi
Indian Institute of Astrophysics (IIA)



Instructors:

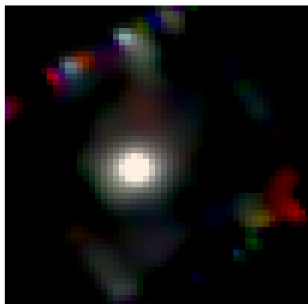
Javier, Nimisha, Themiya, Stacey

Introduction

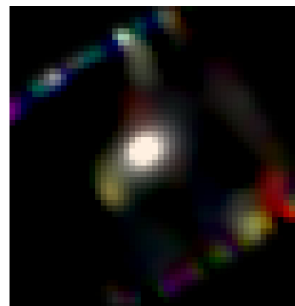
- At high redshifts, quiescent galaxies which are dispersion supported and slow rotators are far less common.
- Previous studies have revealed such galaxies upto $z \sim 2$.
- We study a massive, quiescent galaxies at $z > 3$ with NIRSpec IFU observations taken with G235M.
- Two objects - XMM-VID3-2457 and XMM-VID1-2075 with redshifts 3.49 and 3.45.
- NIRCAM Imaging F444W filter is also used to study morphological features.
- Previous spectroscopic studies for XMM-VID1-2075 as part of the Massive Ancient Galaxies (near-Infrared) at $z > 3$ confirmed $z = 3.45$, large stellar mass ($M_* = 3.3 \times 10^{11} M_\odot$), and low star formation rate ($SFR < 1 M_\odot/\text{yr}$).
- A large stellar velocity dispersion $\sigma_{*,\text{Re}} = 379 \text{ km/s}$
-



Elliptical galaxy



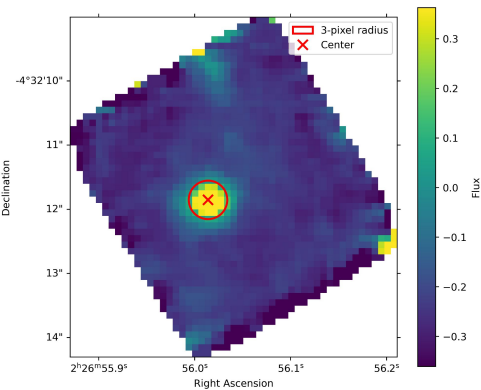
XMM-VID3-2075



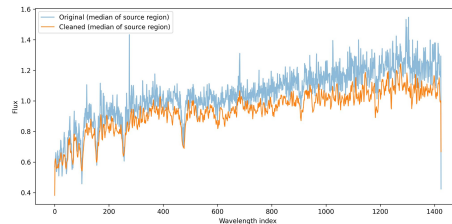
XMM-VID1-2457

RGB images

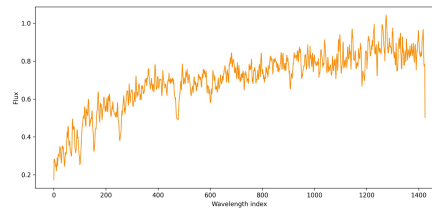
NIRSPEC IFU Data Reduction and spectra extraction



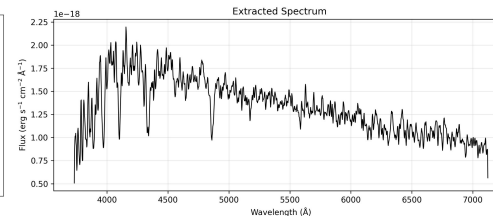
XMM-VID3-2075



Cosmic Ray Removal



Bkg subtracted spectra

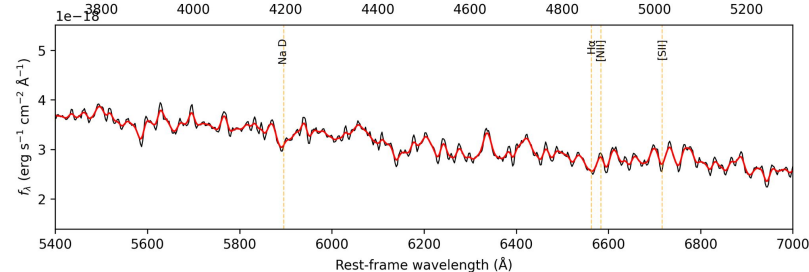
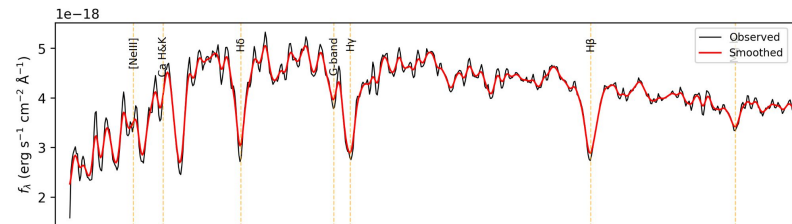


Final extracted spectra

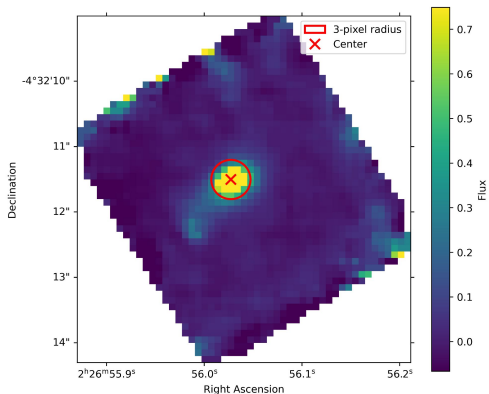
Line identification

Absorption Lines:

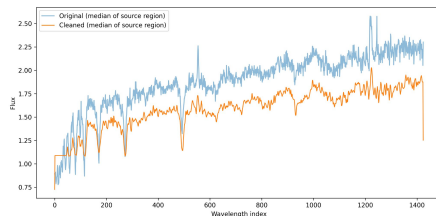
**H α , H β , H γ , H δ
Ca H & K
[NeIII]**



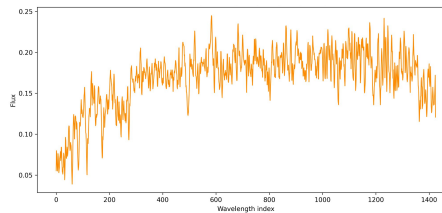
NIRSPEC IFU Data Reduction and spectra extraction



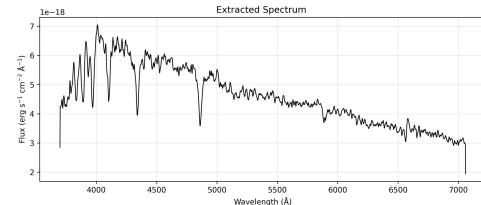
XMM-VID3-2457



Cosmic Ray Removal



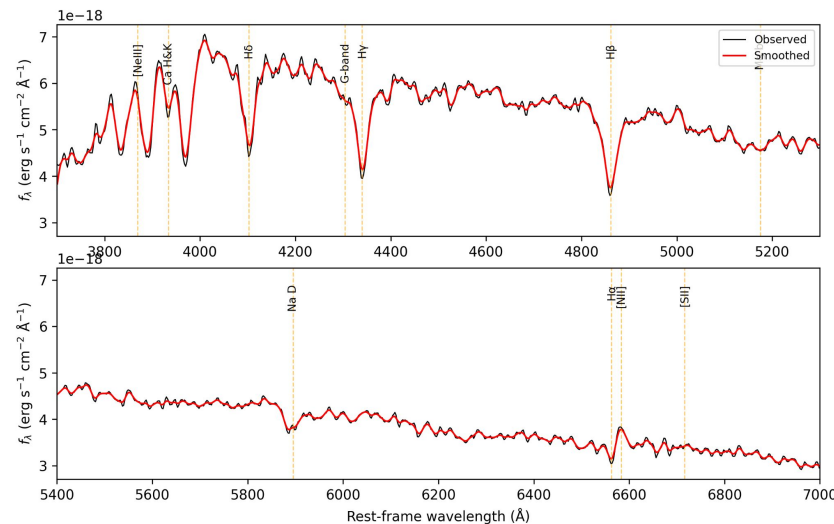
Bkg subtracted spectra



Final extracted spectra

Line identification

Absorption Lines:
H α , H β , H γ , H δ
Ca H & K
[NeIII]



BPT classification

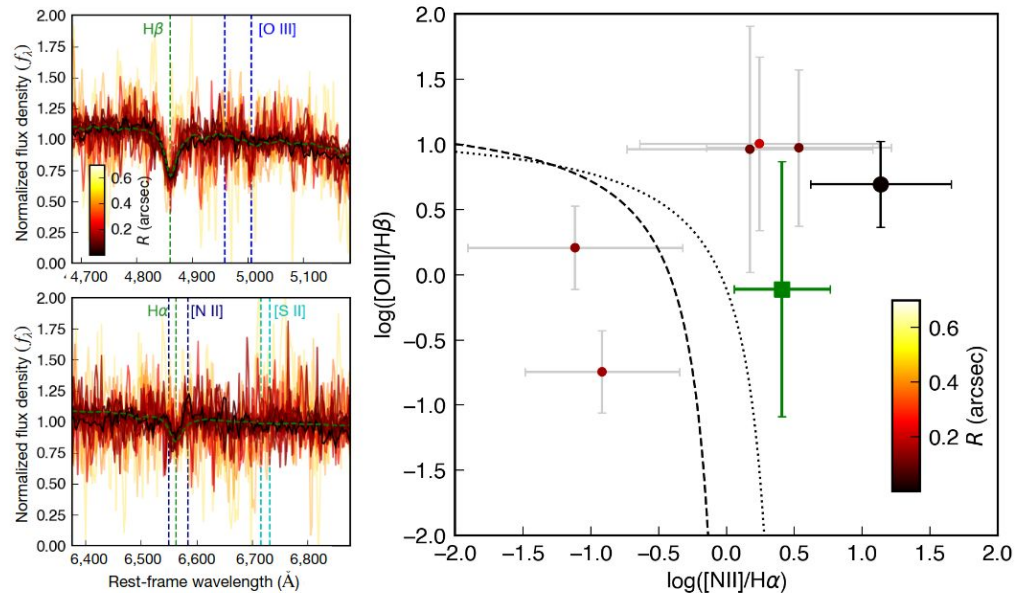
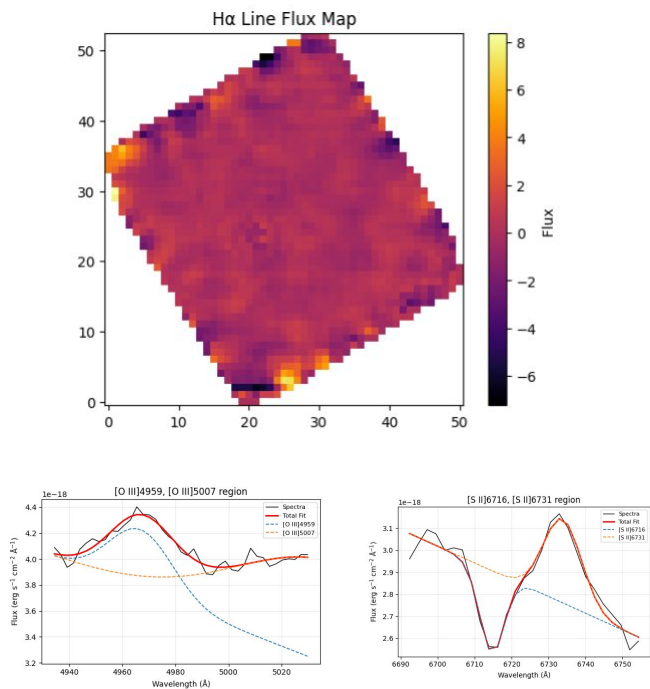
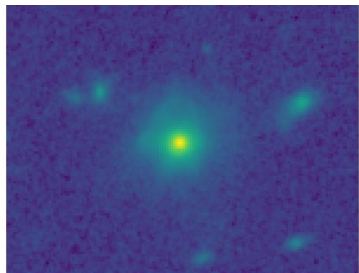


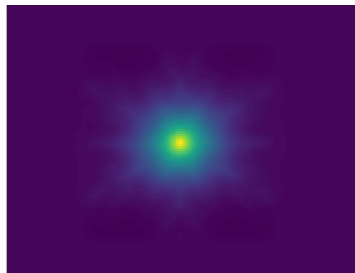
Fig. 6 Analysis of emission line ratios. **Left:** The spectra around the H β and [O III] features (top) and the H α and [N II] features (bottom) colored by the distance of the bin from the galaxy center. The best-fit stellar template to the spectrum of the entire galaxy is shown in green. **Right:** The BPT diagram for discrimination between AGN and star-formation. Only those Voronoi bins with line ratio uncertainties < 1 dex are shown. Points are colored in the same manner as the left panel, and the green square represents the lines strengths from the fit to the spectrum of the entire galaxy. The central spaxel (black) shows evidence of [N II] emission in the core of the galaxy consistent with an AGN.

NIRCAM F444W Image fitting using Galfit

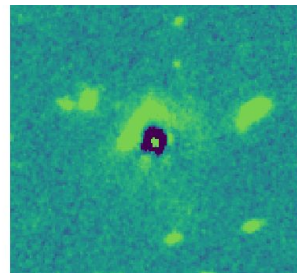
Galaxy



Model



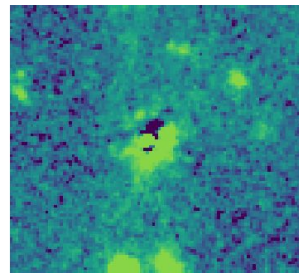
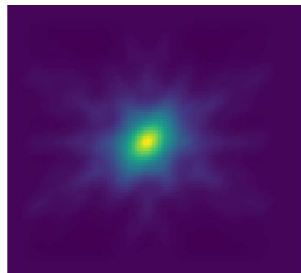
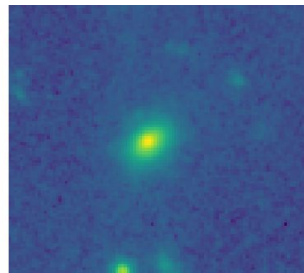
Residual



Sersic Index:
 $n = 3.40 \pm 0.07$

$3.87 \leq n \leq 4.07$

XMM-VID3-2075



$n = 1.34 \pm 0.08$

XMM-VID3-2457

Stellar Kinematics

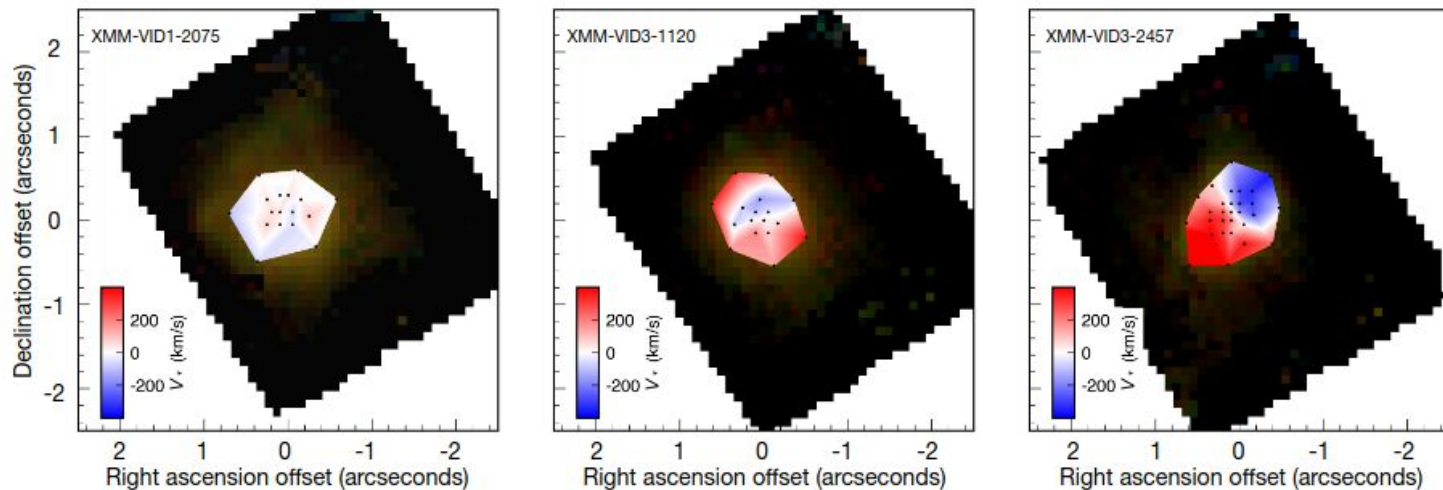
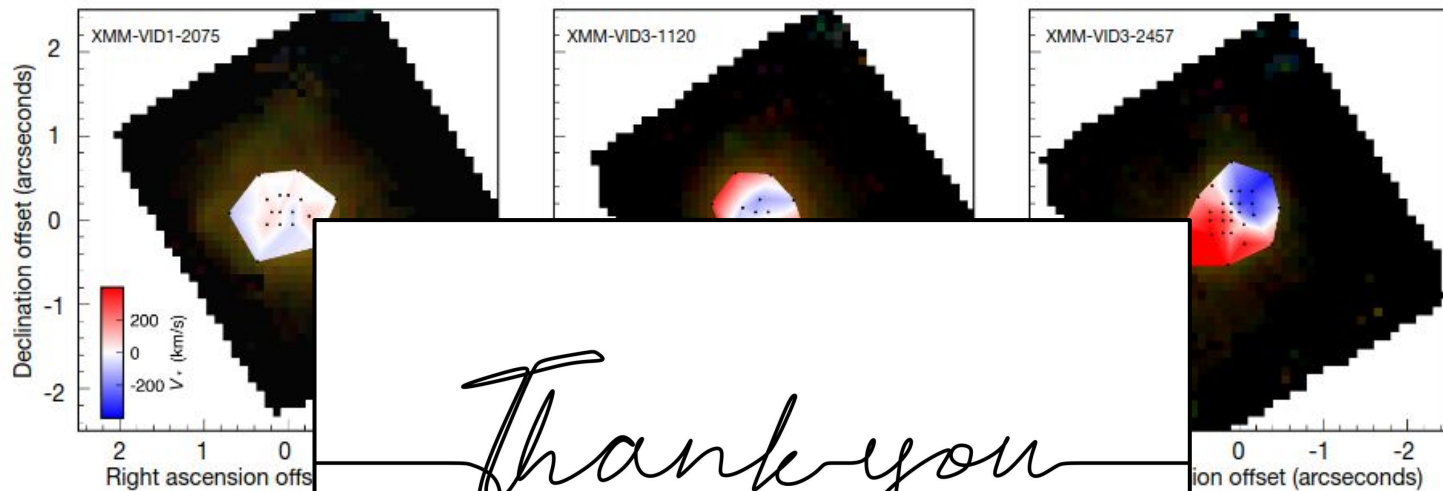


Fig: The stellar velocity offsets relative to the systemic velocity

Forrest et al. 2025

XMM-VID1-2075 is the first slow-rotator confirmed via stellar kinematics at $z \gtrsim 2$.

Stellar Kinematics



Thank you

Forrest et al. 2025

XMM-VID1-2075 is the first slow-rotator confirmed via stellar kinematics at $z \gtrsim 2$.