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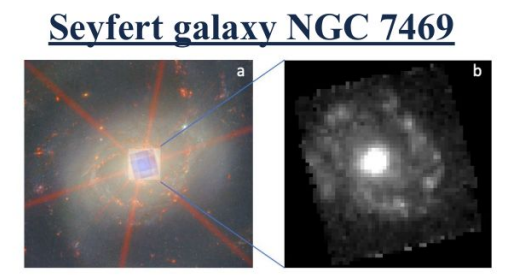
Spectral Emission Characteristics of NGC 7469

A Hands-on Workshop with JWST and UVIT

Ruchika Dhaka
PhD Scholar
Department of Physics, IIT Kanpur

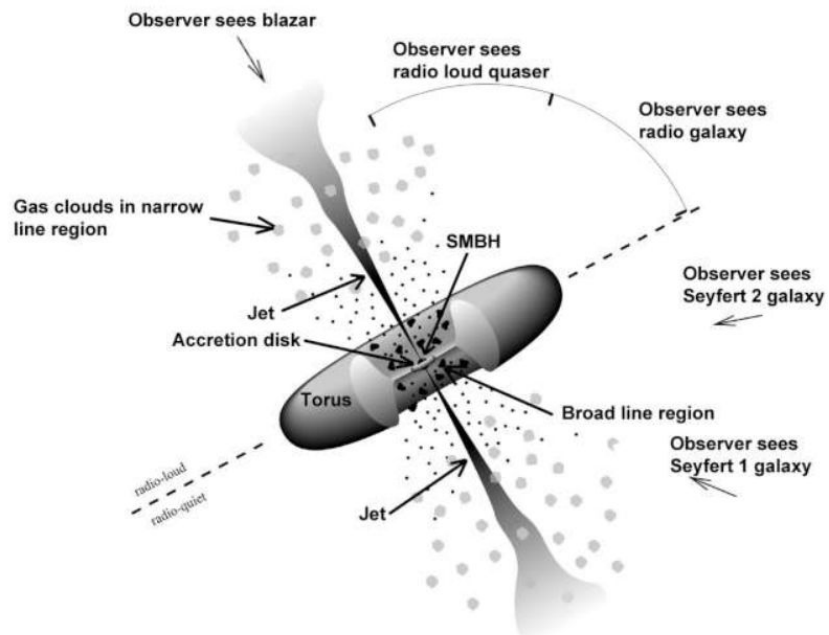
Introduction of AGNs

Active Galactic Nuclei (AGNs) are the extremely luminous central regions of some galaxies, powered by **accretion of matter onto a supermassive black hole** (SMBH) at their cores.



Credit: Adapted from Javier's talk

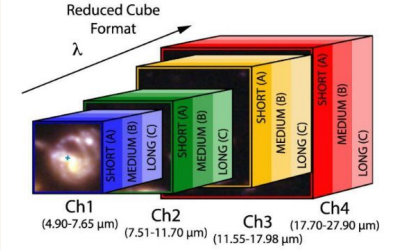
redshift=0.01627



Strong emission across radio to X-rays Prominent

NGC 7469 with Medium Resolution Spectrograph (MRS)

Total number of Channels and Bands:
Channels: 1, 2, 3, 4
Bands: SHORT, MEDIUM, LONG

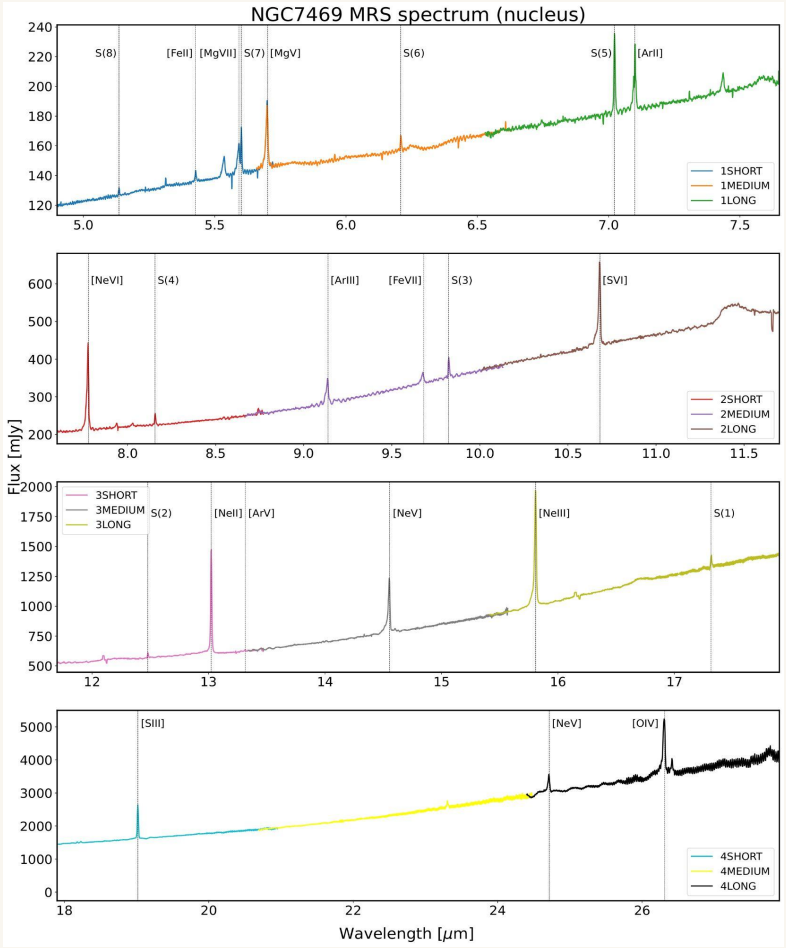


Two array detectors of 1024×1024 pixels FASTR1 & SLOWR1 readouts mode

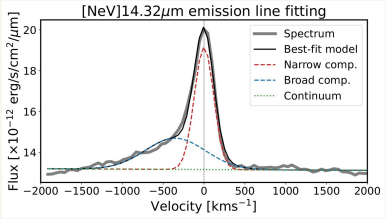
FoV: 3.7″×3.7″ (Ch1) – 7.4″×7.9″ (Ch4)

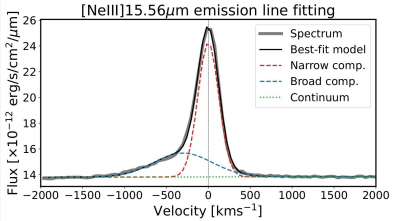
Slice width: 0.18″ (Ch-1) – 0.64″ (Ch-4)

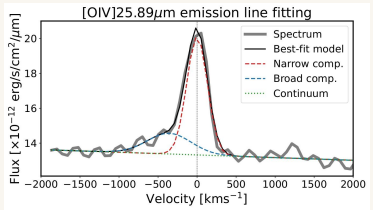
Spectral resolution: R ≈ 1500–3500

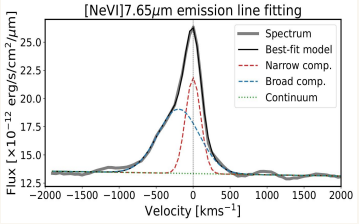


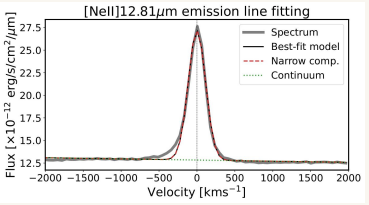
Characterisation of line profiles of high-excitation and coronal emission lines in the nuclear spectrum of NGC 7469



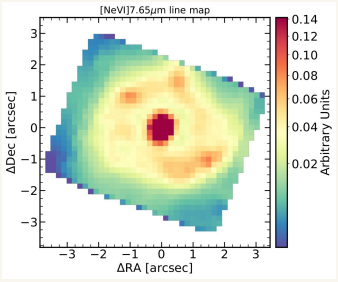


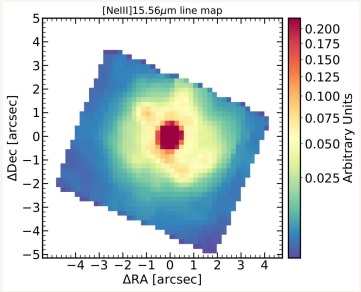


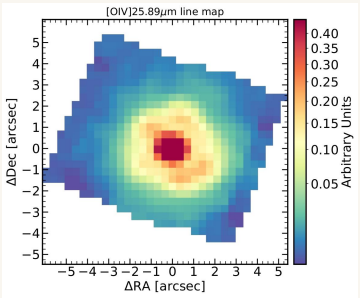


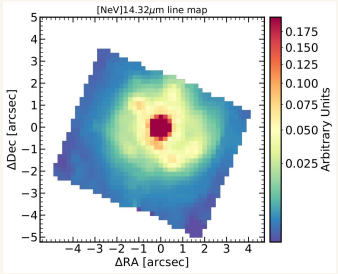


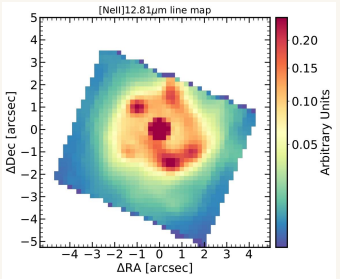
Emission line maps in the central region of NGC 6552 generated using the MRS channels









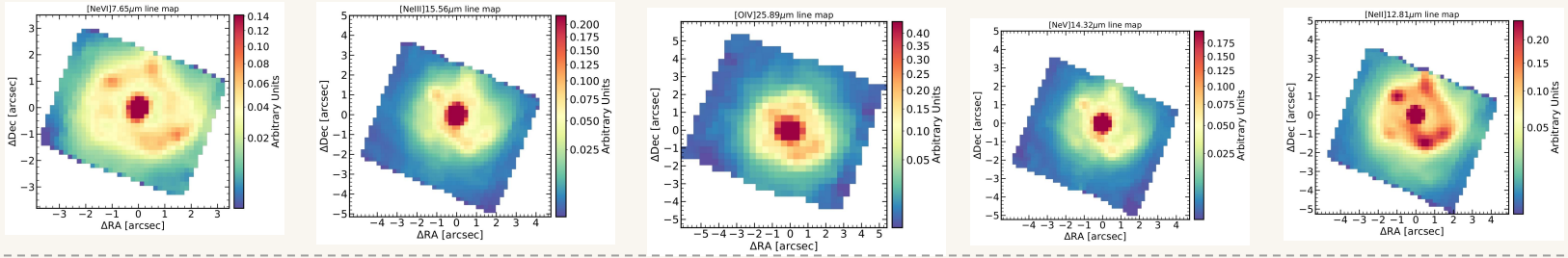


Strong high-ionization lines ([Ne V], [Ne VI], [O IV]) indicate **AGN dominance** with some contribution from circumnuclear star formation.

Mid-IR Line Ratios and Seyfert Classification

Comparison based on Pereira-Santaella et al. (2010, A&A 517, A23).

Ratio	NGC 7469	Seyfert 1 median	Seyfert 2 median
[Ne III]/[Ne II]	**1.44**	≈ 1.1	≈ 0.9
[Ne V]/[Ne II]	**0.87**	≈ 0.9	≈ 0.7
[Ne V]/[Ne III]	**0.60**	≈ 0.5	≈ 0.4
[O IV]/[Ne II]	**1.52**	≈ 1.5	≈ 1.2
[O IV]/[Ne III]	**1.06**	≈ 1.0	≈ 0.8

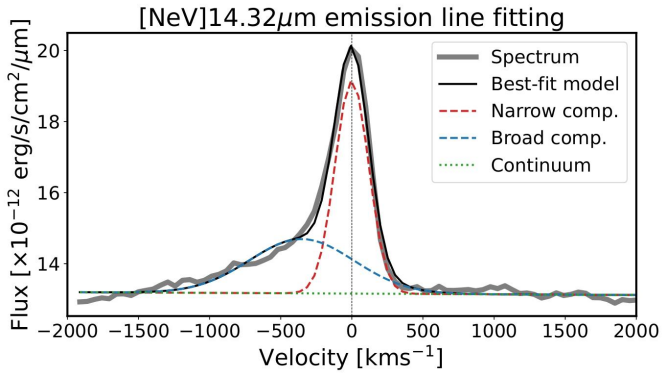


The measured mid-infrared ratios clearly classify NGC 7469 as a Seyfert 1 galaxy. (Pereira-Santaella et al. 2010)

Black Hole Mass Estimate — NGC 7469

- Based on *Dasyra et al. (2008, ApJ 674, L9)* relation using the **[Ne V] 14.32 μm** line width.
- The black hole (BH) mass based on the line FWHM of the high-excitation emission line

$$\log(M_{BH}/M_{\odot}) = 7.86 + 4.31 \log(\sigma / 200\ \mathrm{km\ s^{-1}})$$



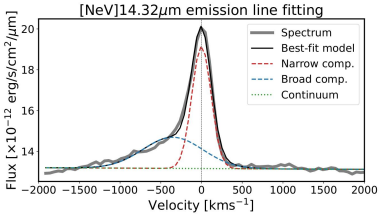
Results (from [Ne V] narrow component):

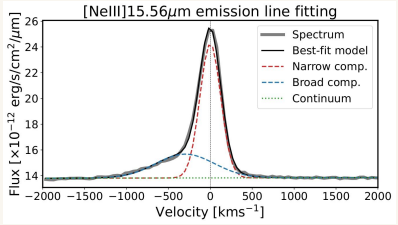
- FWHM = **278.2 km s⁻¹**

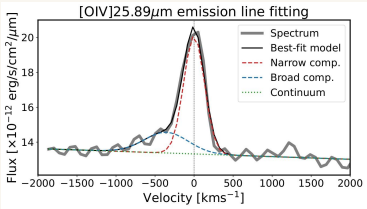
Estimated black hole mass: $M_{BH} \approx 8\times10^{6}\ M_{\odot}$

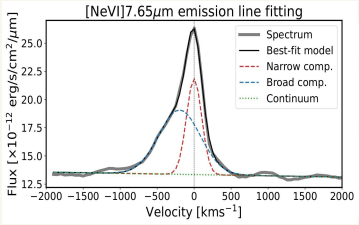
- The derived mass agrees with previous reverberation-based estimates (**~10^{7} $M_{\odot}$**). (Peterson et al. (2014))

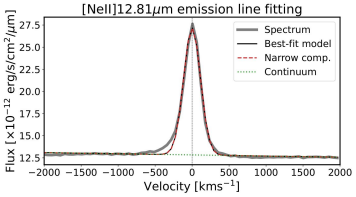
Highly ionised nuclear outflow











Line	FWHM (km/s)	Velocity offset (km/s)	σ (km/s)	Outflow Velocity (km/s)
[Ne V] 14.32 μm	865.0	351.2	368.1	**1087**
[O IV] 25.89 μm	659.9	356.0	280.8	**918**
[Ne VI] 7.65 μm	659.4	195.6	280.6	**757**
[Ne III] 15.56 μm	819.7	301.3	348.8	**999**

Outflow maximum velocity:

$$V_{\text{peak}} + 2 \times \sigma_{\text{blue}},$$

Ref: Javier + 2023, A&A

- The **blue-shifted velocity components** identified in all atomic emission lines are interpreted as being due to the **presence of outflowing material close to the AGN.**
- High-velocity outflow with offset velocities of **+195–350 km s⁻¹**.
- All four lines show **high outflow velocities (~750–1100 km s⁻¹)** — typical of **AGN-driven ionized winds**.
- evidence for a highly ionised, AGN-powered, and fast outflowing gas.

Thanks for your attention