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Spectral Emission Characteristics of NGC 7469

A Hands-on Workshop with JWST and UVIT

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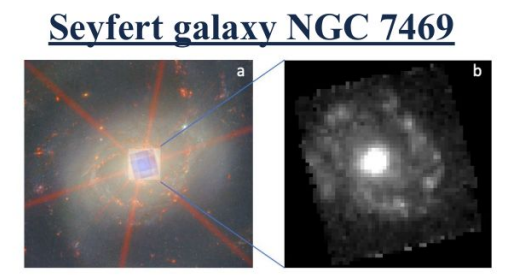
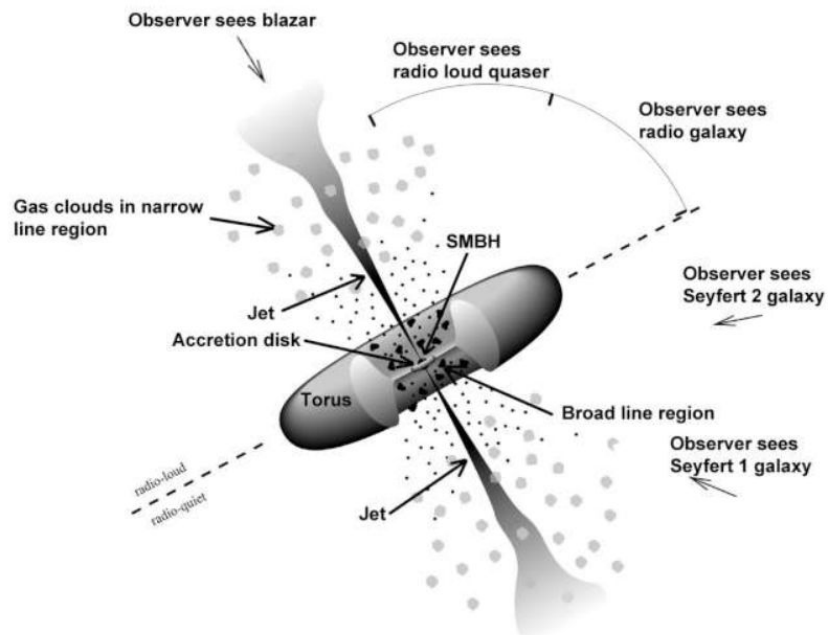
Introduction of AGNs

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

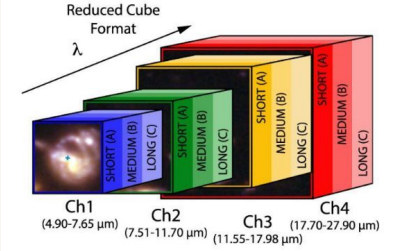
redshift=0.01627



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

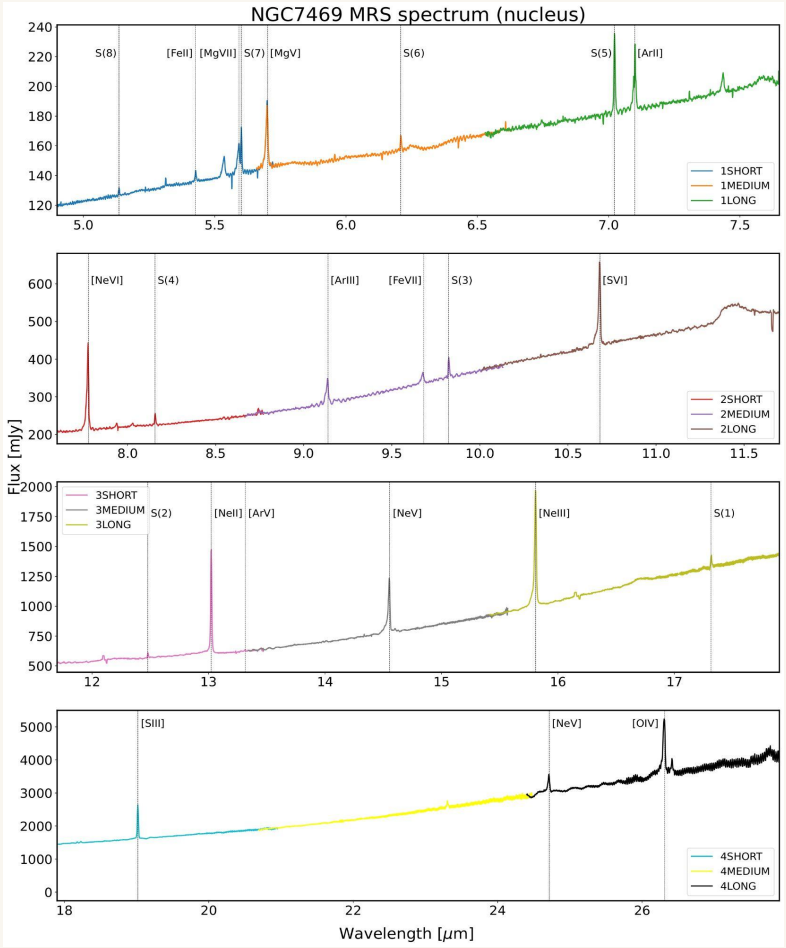


Two array detectors of 1024×1024 pixels FASTR1 & SLOWR1 readouts mode

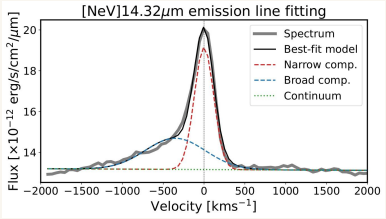
FoV: 3.7″×3.7″ (Ch1) – 7.4″×7.9″ (Ch4)

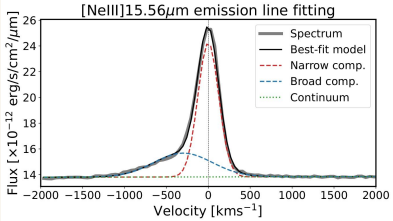
Slice width: 0.18″ (Ch-1) – 0.64″ (Ch-4)

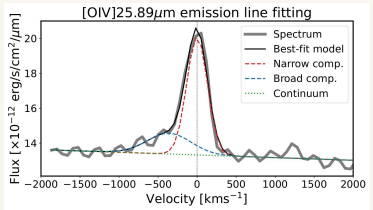
Spectral resolution: R ≈ 1500–3500

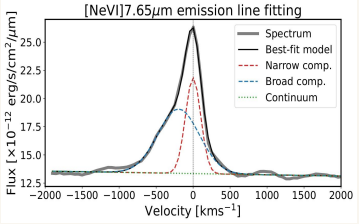


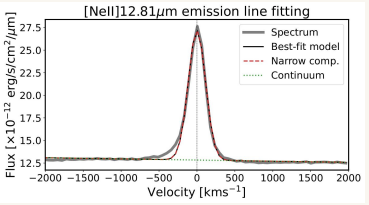
Characterisation of line profiles of high-excitation and coronal emission lines in the nuclear spectrum of NGC 7469



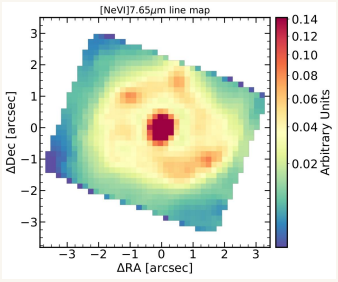


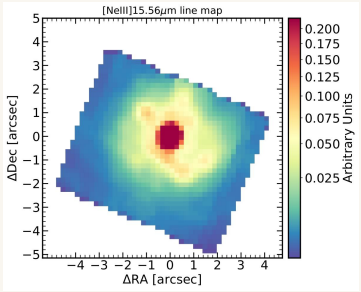


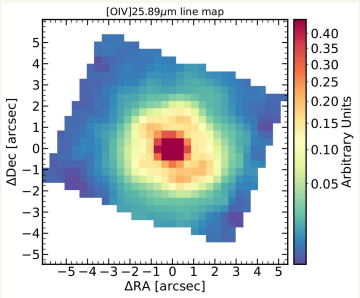


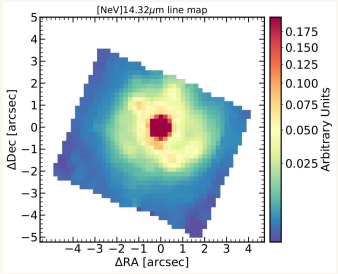


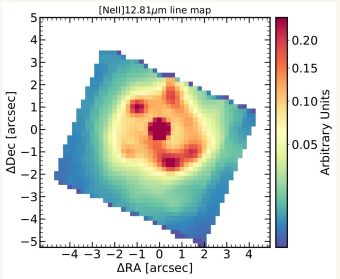
Emission line maps in the central region of NGC 6552 generated using the MRS channels









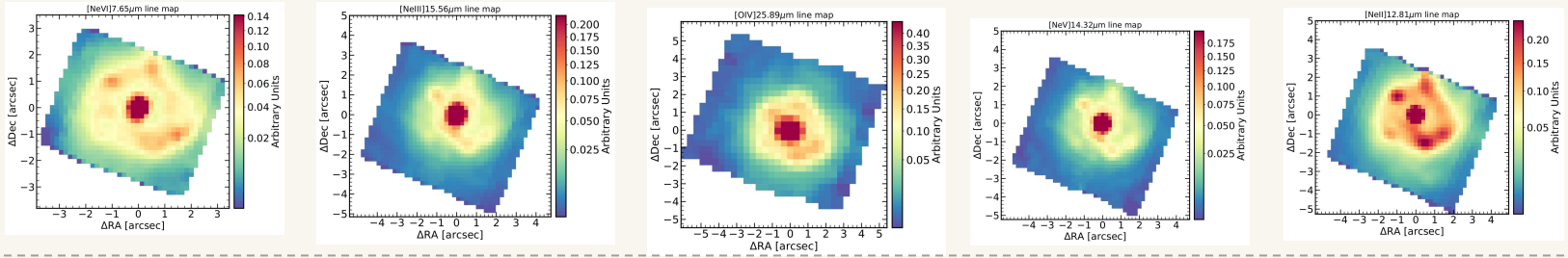


Strong high-ionization lines ([Ne V], [Ne VI], [O IV]) indicate **AGN dominance** with some contribution from circumnuclear star formation.

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 ± 0.6	0.9 ± 0.5
[Ne V]/[Ne II]	**0.87**	0.9 ± 0.5	0.7 ± 0.4
[Ne V]/[Ne III]	**0.60**	0.5 ± 0.3	0.4 ± 0.3
[O IV]/[Ne II]	**1.52**	1.5 ± 0.8	1.2 ± 0.6
[O IV]/[Ne III]	**1.06**	≈ 1.0	≈ 0.8

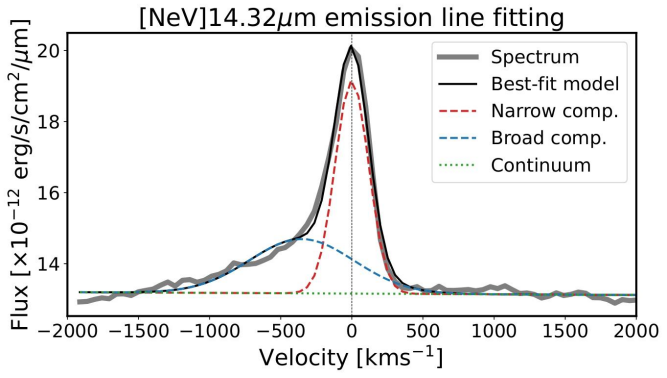


The measured mid-infrared ratios clearly classify NGC 7469 as a Seyfert 1 galaxy. (Pereira-Santaella et al. 2010)

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

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



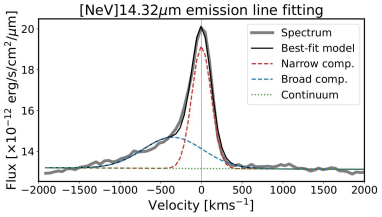
Results (from [Ne V] narrow component):

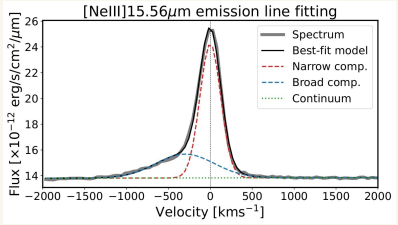
- FWHM = **278.2 km s⁻¹**

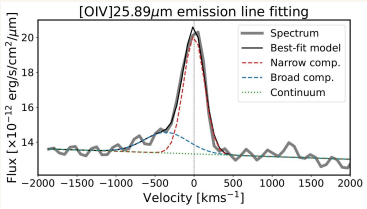
Estimated black hole mass: $M_{BH} \approx 8\times10^{6}\ M_{\odot}$

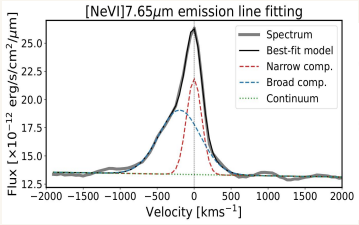
- The derived mass agrees with previous reverberation-based estimates (**~10^{7} $M_{\odot}$**). (Peterson et al. (2014))

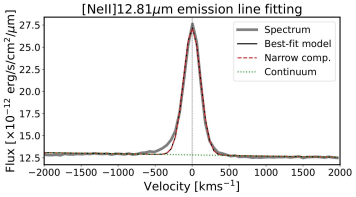
Highly ionised nuclear outflow











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