GOALS-JWST: Gas Dynamics and Excitation in NGC 7469 revealed by NIRSpec

Bianchin et al. 2024, ApJ in press , arXiv:2308.00209

Introduction

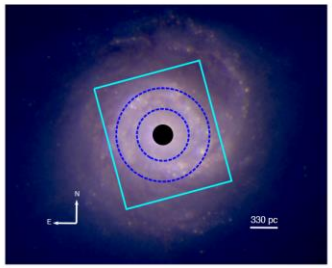
LIRGs have an extreme condition with starburst (SB) & nuclear activity

- Gas excitation = Mix of AGN, star-formation (SF), shock
- Kinematics = Outflow, Inflow by merger, AGN, and SB

NGC7469

- Type-1.5 (Broad line) AGN
- SF ring (330-616 pc)
- Nuclear outflow affecting 400-600pc

→ Ideal target to investigate AGN-SB-ISM interaction



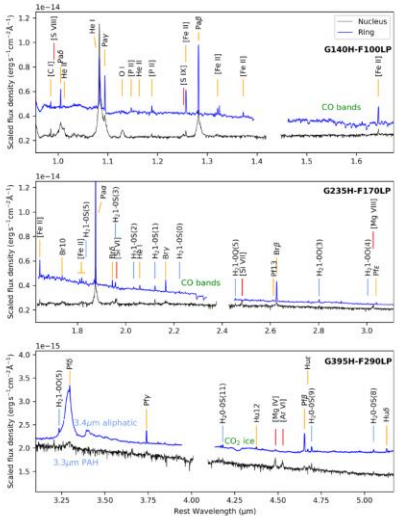
Data

JWST-NIRSpec IFS

- R=2700 -> velocity resolution = 110 km/s
- Three grating to cover 0.97-5.27um
- Dither 3"x3" FoV -> 4.2"x4.8"=1.4x1.6kpc² FoV

→ Mainly focuses on HI, [FeII], H_2

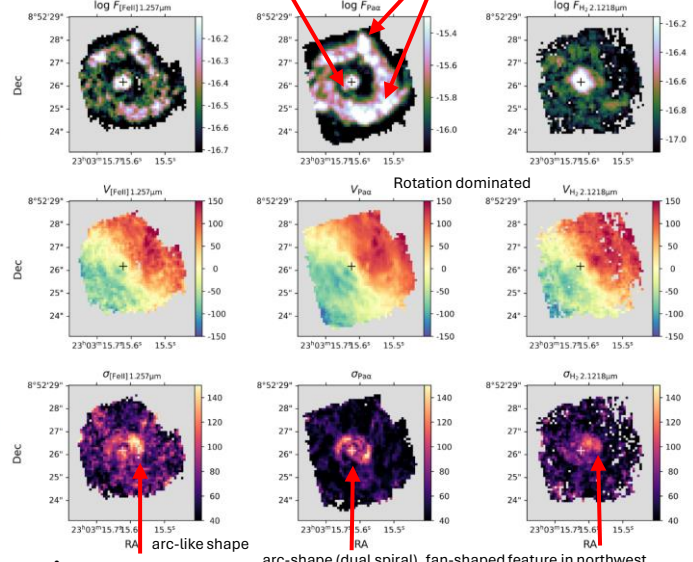
SF ring = Narrow lines(H, [FeII], H2), PAH, CO absorption
Central part = Broad permitted lines, coronal lines



All trace SF ring and central part
Inner ISM region has an order of magnitude lower surface brightness

More concentrated
More extended & diffuse
Like spiral pattern

Tail connecting the ring to AGN
Knots



Gas Excitation

H2/Brγ vs [FeII]1.257um/Paβ diagram (Riffel+2013, 2021b)

→ SB, AGN, shocks

- SF ring shows low line ratios
- High line ratios at the nucleus and western inner ISM region

→ Except SF ring, the bulk of the ISM is excited by AGN with a small number of regions excited by shocks.

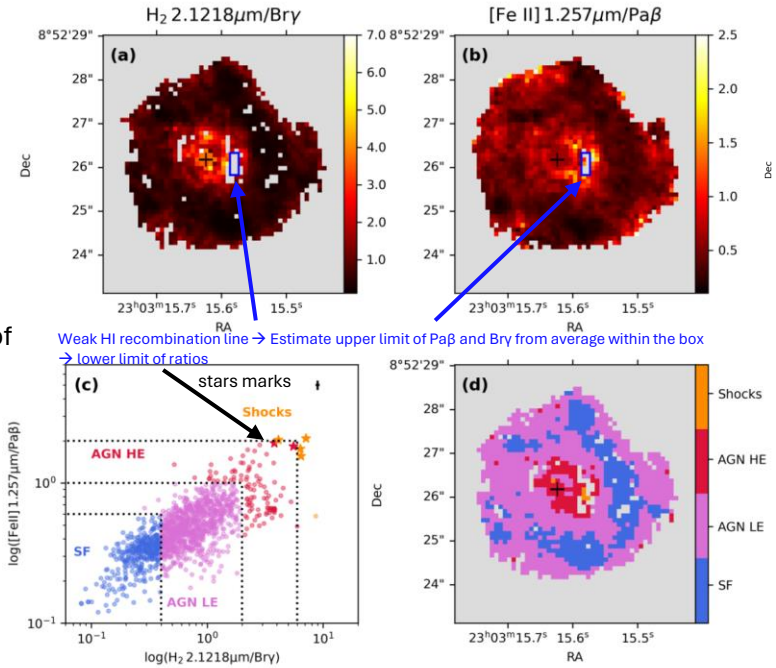
SF discontinuity in the East

→ Effect of outflow? No clear evidence (Garcia-Bernete+2022)

Shocked gas information

- shock-like line ratios are seen in the western part

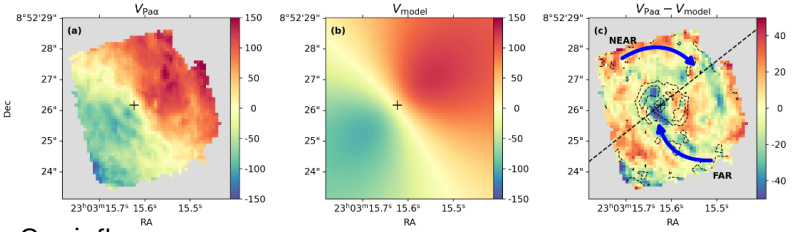
→ Also shows high velocity dispersion in H2 (also discussed in U+2022)



→ Line-ratio and velocity dispersion are indicators of the same shocked gas?

- [FeII] is likely to be excited by shock due to radio jet extending east-west?
- [FeII] in SF ring is likely due to shocks by supernovae

Gas Dynamics



Gas inflow

- Spiral shape in velocity dispersion map was interpreted as a gas inflow in previous studies (Raimundo+2019: Mrk150, Storchi-Bergemann+2007: NGC6951)
- Arm-shaped morphology in velocity residual map

Inflow rate $\dot{M}_{in} = N_e V_{in} A m_p n_{arms} = 0.2 - 17 M_\odot \mathrm{yr}^{-1}$

- One order larger than accretion rate of AGN by Armus+2023

Gas outflow: compact, high dispersion (σ=800kms^{-1})

- Outflow rate = $0.14 - 0.18 M_\odot \mathrm{yr}^{-1}$ → comparable to inflow(?)
- Caused by radio jet (discussion about kinetic power)

→ Inflow and outflow are self-regulating

Short summary

- AGN dominates inner-ISM with a small fraction of shocked gas (compact radio jet) and SF rings
- Observed gas inflow and outflow are in self-regulating feeding-feedback process