NGC 4258: A Laboratory for AGN and Star Formation Impacts on the ISM

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NGC 4258: Does the jet impact the disk?

- NGC 4258 (M106), Seyfert 1.9, SAB(s)bc, 7.2 Mpc [1]
  - Anomalous radio structure could be jet impacting the disk [2,3]
  - May illustrate the interplay between AGN and star formation
- Previous studies found no evidence of jet shocked dust [4]
  - Concluded higher resolution than Spitzer 8um is required
- NIRCam Imaging
  - Search for shocked gas stratification along radio emission
  - Filter-pairs for line extraction via continuum subtraction

Species	Line filter	Continuum filter	Diagnostic Utility
[FeII]	F164N	F162M	J Shocks (v < 300 km/s, T < 8000 K)
Pa-α	F187N	F182M	Star formation rate
H_2	F212N	F210M	C Shocks (v < 50 km/s, T < 3000 K)
PAH	F335M	F300M	Star formation & PAH survivability
Br-α	F405N	F430M	Star formation rate

- 50% of dither pattern failed due to guide star issues
  - Remaining observations planned for early 2024

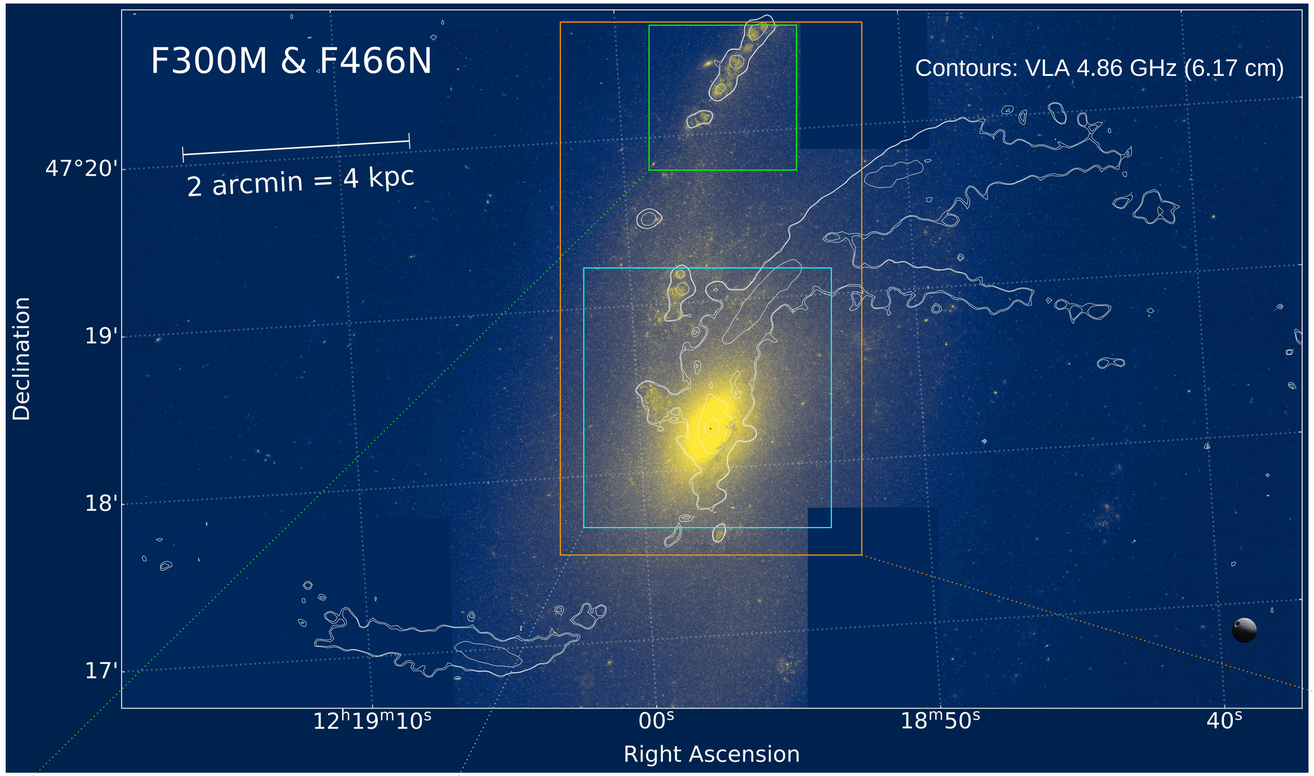
Preliminary Conclusions & Next Steps

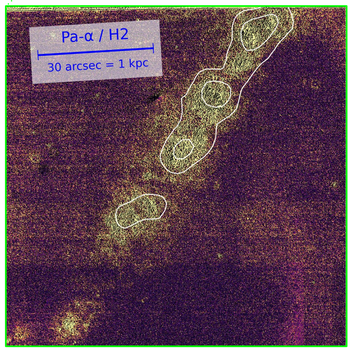
- Anomalous radio structure impacts minimally with observed ISM
  - Shock tracers do not reveal much impact on ISM from radio
  - Radio structure could be out-of-plane jet
  - Or, emission in the NIR may still suffer from dust extinction
- Instead, ISM dominated by star-forming clusters
- Next steps:
  - Complete remaining observations in early 2024
  - Assess impact of radio jet on nuclear ISM
  - Assess excitation of ISM by young star clusters
  - Identify embedded young YSOs via Color-Magnitude diagrams
  - Determine star formation rate via IMF fitting
  - Search for CO/ice absorption near galaxy center [5]

Acknowledgements and References

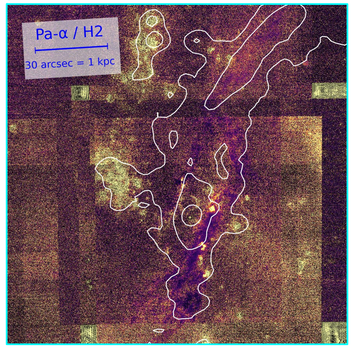
NFC and IN were supported by an NASA Postdoctoral Program Fellowship at NASA Goddard Space Flight Center, administered by Oak Ridge Associated Universities. Data reduction methods were developed from the *jwst* and *jhat* (Armin Rest, STScI) python libraries.

1. Herrnstein et al. Nature 1999, DOI: 10.1038/22972
2. Ogle et al. ApJ 2014, DOI: 10.1088/2041-8205/788/2/L33
3. Appleton et al. ApJ 2018, DOI: 10.3847/1538-4357/aaed2a
4. Laine et al. AJ 2010, DOI: 10.1088/0004-6256/140/4/1084
5. Ginsburg et al. 2023, arXiv:2308.16050

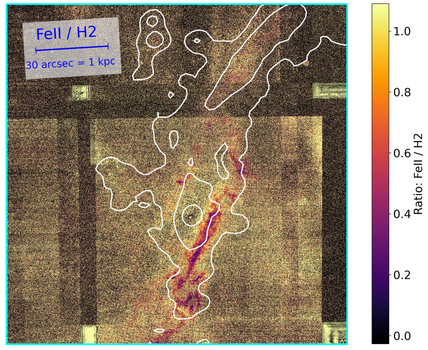




Ratio image of continuum-subtracted Pa-α and H2 images in the north spiral arm



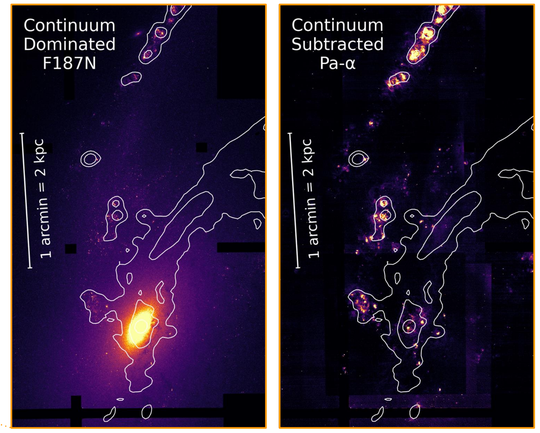
Ratio image of continuum-subtracted Pa-α and H2 images in the nucleus region



Ratio image of continuum-subtracted [FeII] and H2 images in the nucleus region

Continuum-Subtraction & Line Ratios

- Line extraction via continuum subtraction
  - Match background of medium-bandwidth continuum filter images to narrow-bandwidth line images
  - Subtract matched continuum background from line
- Compute line ratio maps
  - Convolve shortwave to longwave using Webb PSFs
  - Reproject onto same pixel grid before taking ratio



Comparisons of before (left) and after (right) continuum subtraction for Paschen-α (upper) and polycyclic aromatic hydrocarbon (PAH, lower) images