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 8 μm is required
- Goal: Explore origin of radio emission and related impacts on ISM
  - Use NIRCam to image shock-excited gas and star formation
  - 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

- Continuum-subtracted line maps reveal wealth of astrophysics
  - [FeII] and H_2 emission coincident with radio emission
    - Suggests radio emission more likely due to shocks than a jet
    - If radio is from a jet, jet must be aligned with disk out to ~6 kpc
  - Star-forming regions traced by PAH and Pa-α emission
  - CMD identifies candidate YSOs, which fit well to SED model
- Next steps:
  - Complete remaining observations in early 2024
  - Measure impact of nuclear wind on ISM and star formation
  - Examine stratification of shocked gas along radio structure
  - Identify embedded young YSOs via Color-Magnitude diagrams
  - Relate stellar populations and YSOs to galactic structure
  - Determine star formation rate via IMF fitting
  - Search for CO/ice absorption near galaxy center [5]

Acknowledgements and References

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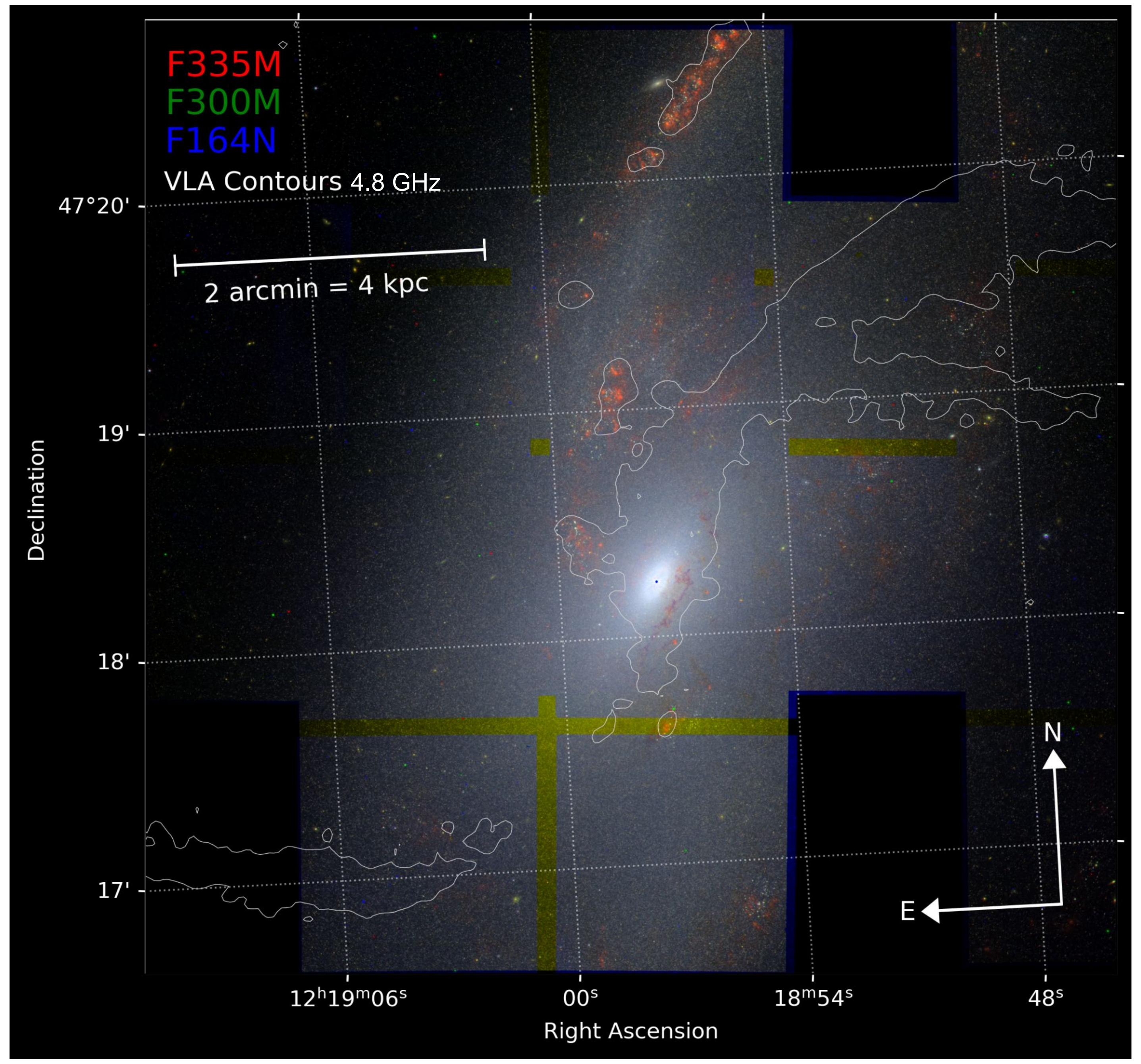
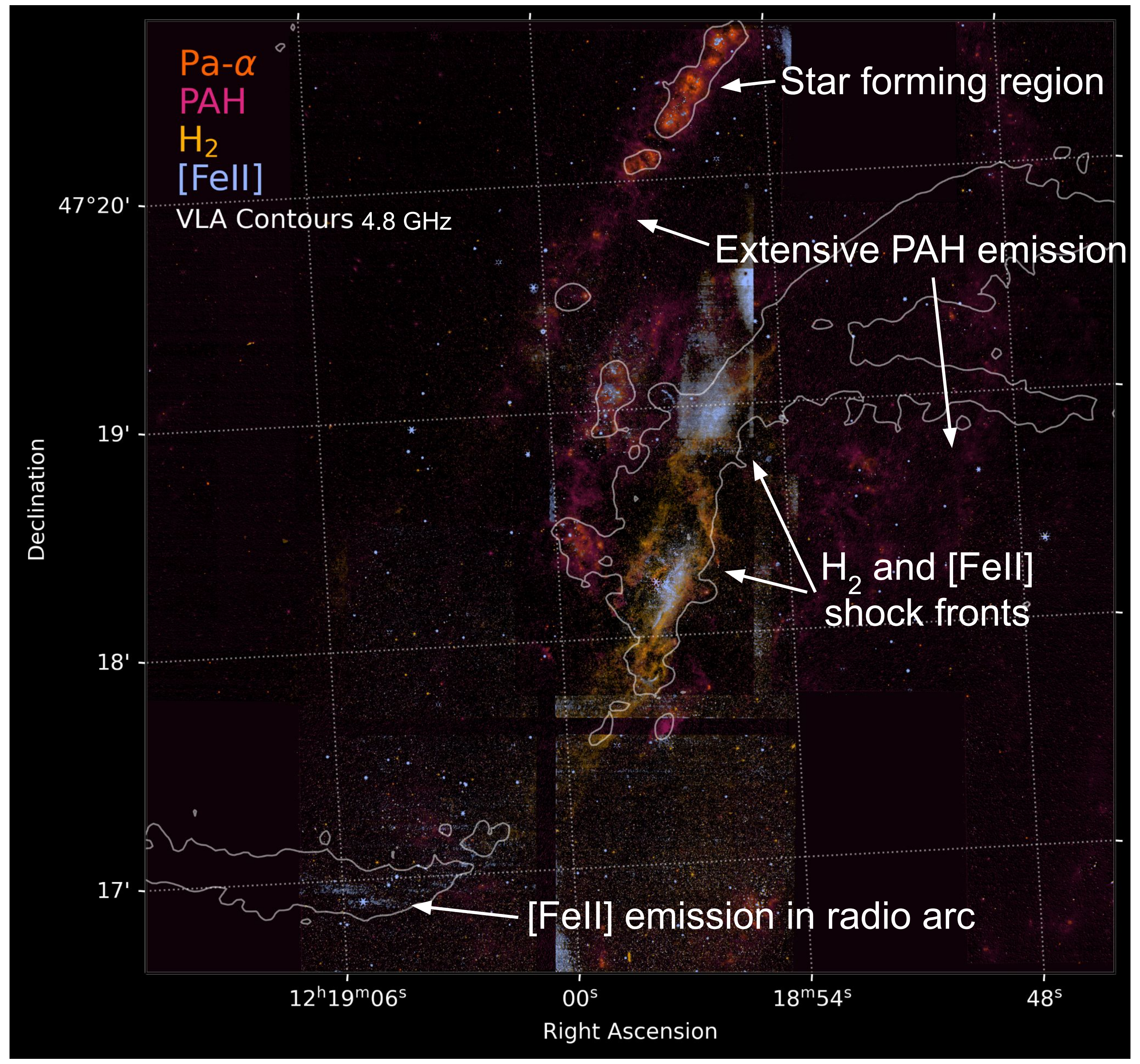
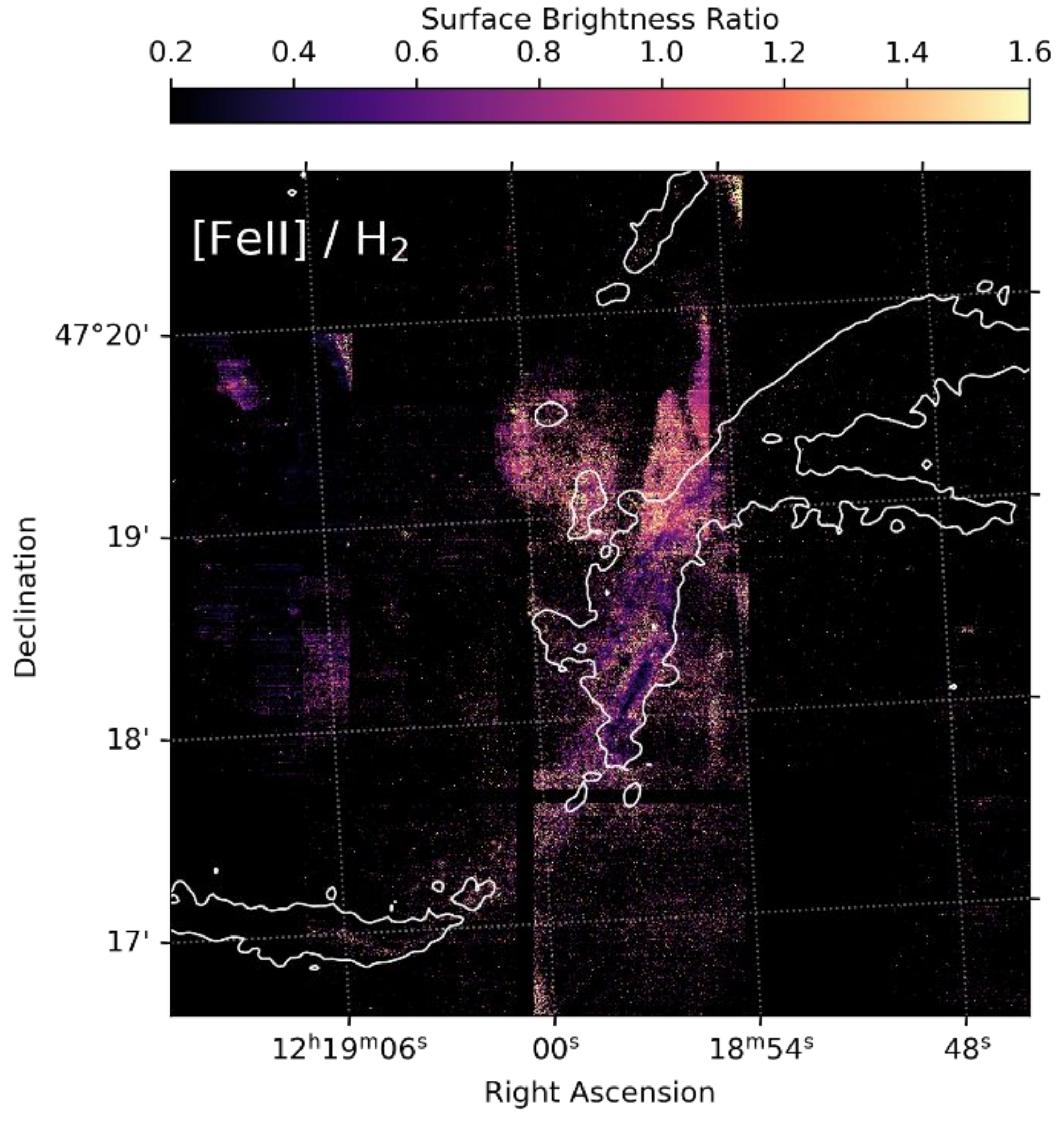


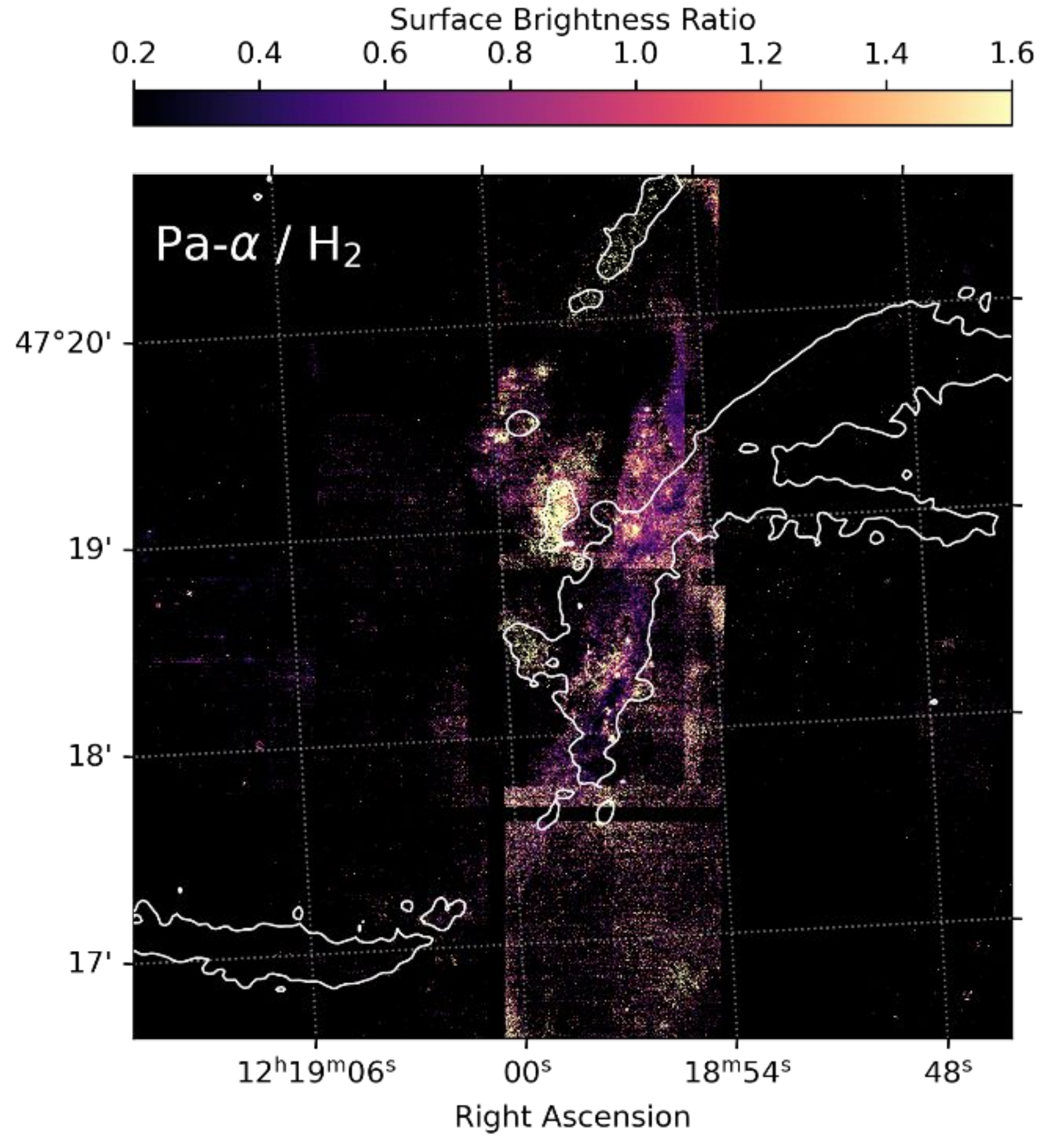
Composite image of NGC 4258 using continuum-dominated NIRCam filters, with contour lines showing 4.86 GHz emission.



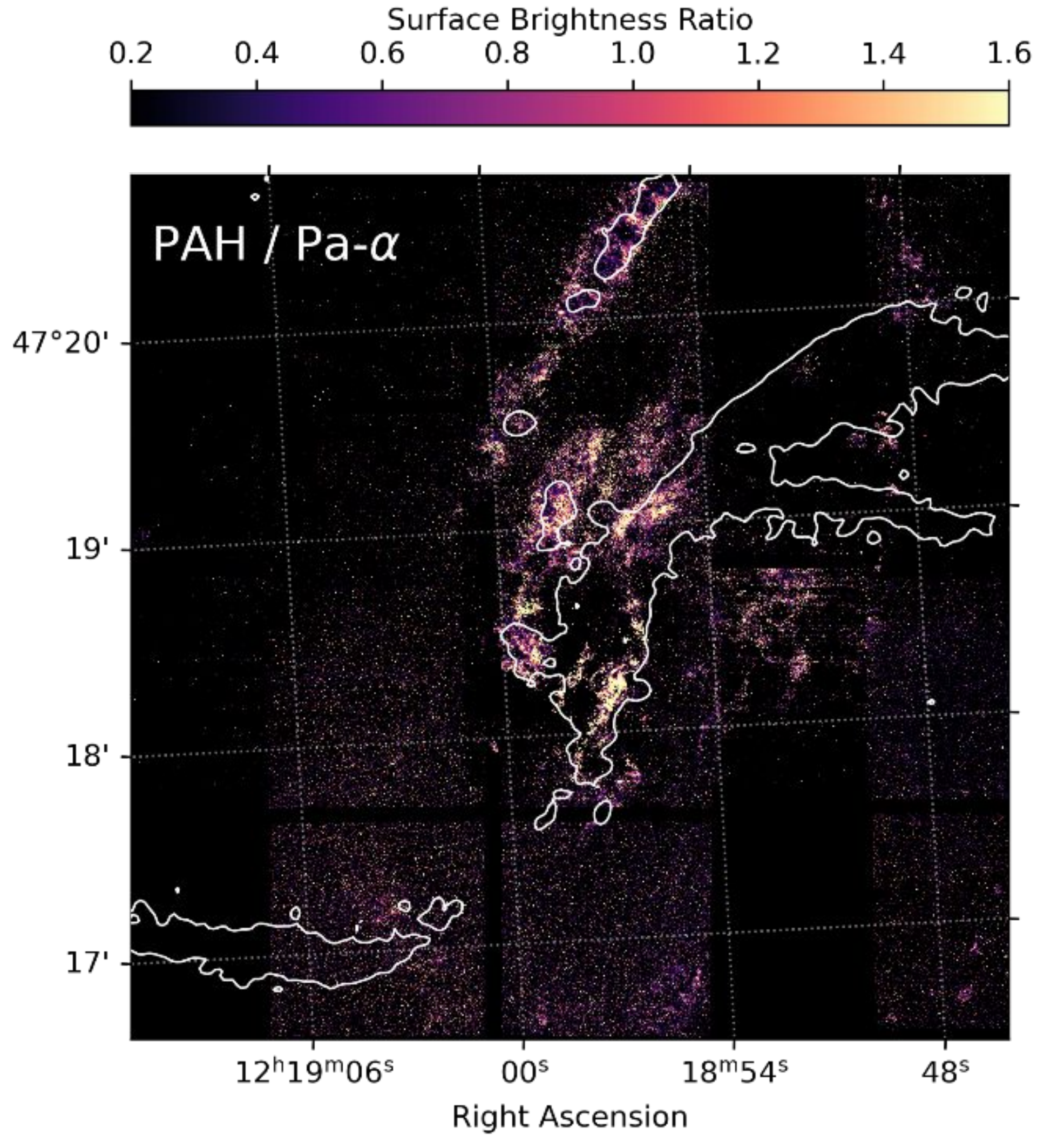
Composite image of continuum-subtracted NIRCam data, with contour lines showing 4.86 GHz emission. H_2 and [FeII] trace radio structure. Pa-α and PAH trace star forming regions



Ratio image of continuum-subtracted [FeII] and H_2 images



Ratio image of continuum-subtracted Pa-α and H_2 images



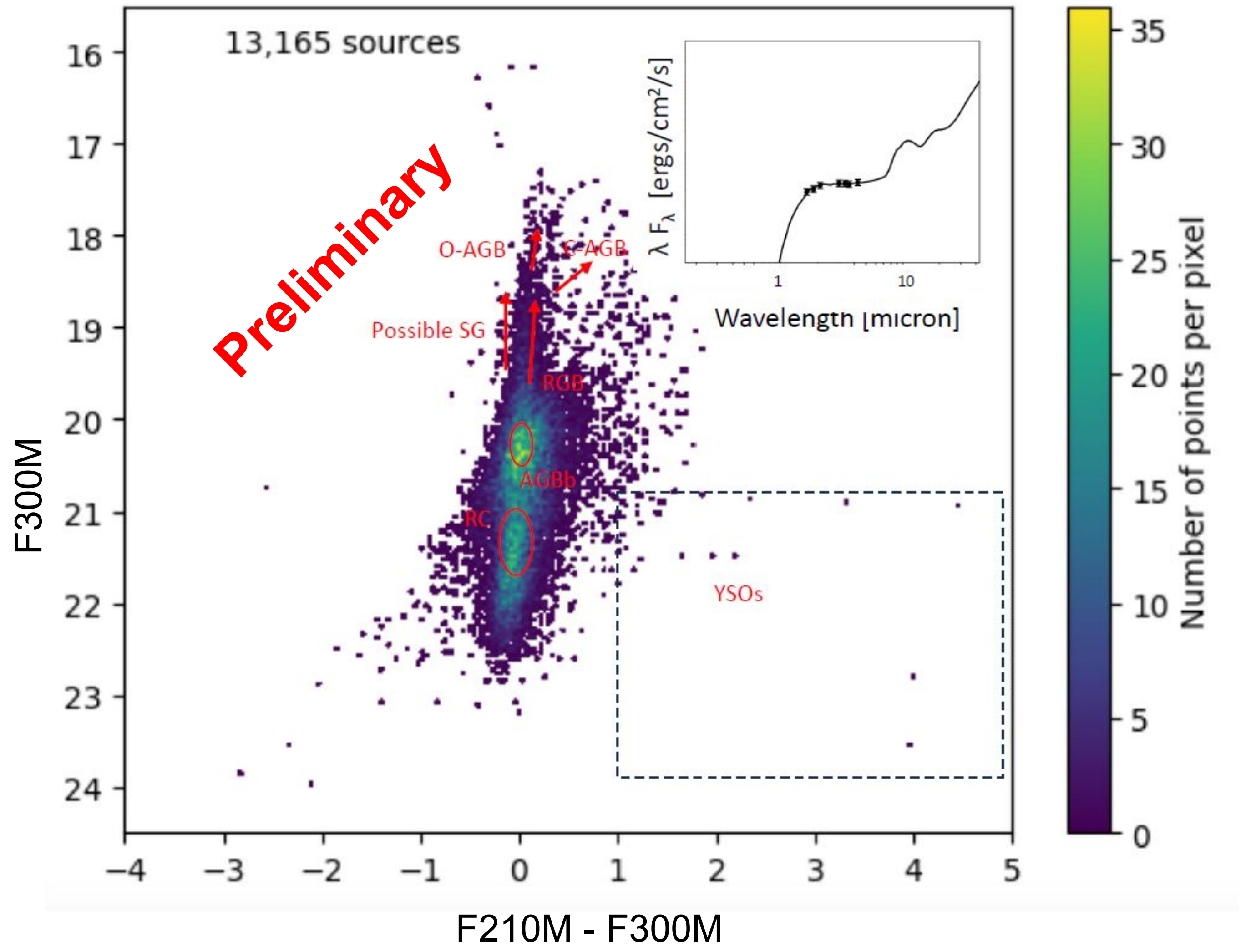
Ratio image of continuum-subtracted PAH and Pa-α images

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 images
- Compute line ratio maps
  - Convolve shortwave to longwave using Webb PSFs
  - Reproject onto same pixel grid before taking ratio

Color Magnitude Diagrams/Spectral Energy Distributions

- Use color magnitude diagram to identify stellar populations
  - F210M-F300M vs F300M: 13,165 total sources identified
    - Red clumps (RC)
    - Asymptotic giant branch bump (AGBb)
    - Red giant branch (RGB)
    - Oxygen-rich AGB (O-AGB)
    - Carbon-rich AGB (C-AGB)
    - Young stellar objects (YSOs)
    - Possible super giants (SG)
- 54 **preliminary** young stellar object (YSO) candidates
  - 53 of the YSOs fit well to YSO SED model
  - YSO best fit masses range from 10 to 20 $M_\odot$
  - Example SED fit shown for one YSO, yields 12 $M_\odot$



Color magnitude diagram used to identify stellar populations. Inset plot shows SED fit of one candidate YSO. SED fits to all YSO candidates yield stellar masses between 10 and 20 $M_\odot$.