Probing ULIRG IRAS F20100-4156 with JWST

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INTRODUCTION

Galaxy evolution requires a **feedback** mechanism to regulate star formation by spewing gas, the constituents of stars **[1,2]**. Models without feedback over-predict the abundance of the highest and lowest mass galaxies **[3]**. **Ultra-Luminous Infrared Galaxies (ULIRGs)** are highly energetic due to their **Active Galactic Nuclei (AGN)**, radiating over 10^{12} L⊙ **[1,4]**. The AGN, given that it is a **supermassive black hole**, constantly accretes matter from the surrounding interstellar medium (ISM) and other galaxies. Approximately 10-40% of mass-energy is converted into thermal energy and, ultimately, **infrared radiation [2,5]**.

Our object of study is the **ULIRG IRAS 20100-4156**, which hosts one of the fastest and most massive cold molecular outflows **[6]**. Both **starburst** and AGN fuel its outflow, making it a starburst-AGN composite system. The **AGN contributes ~79% of the bolometric luminosity**, as estimated using methods described in **[7,8]**. Unlike the cold molecular gas observed in the past, we present new data of the warm molecular and warm ionized outflow utilizing the **James Webb Space Telescope (JWST)**.

PROJECT GOAL

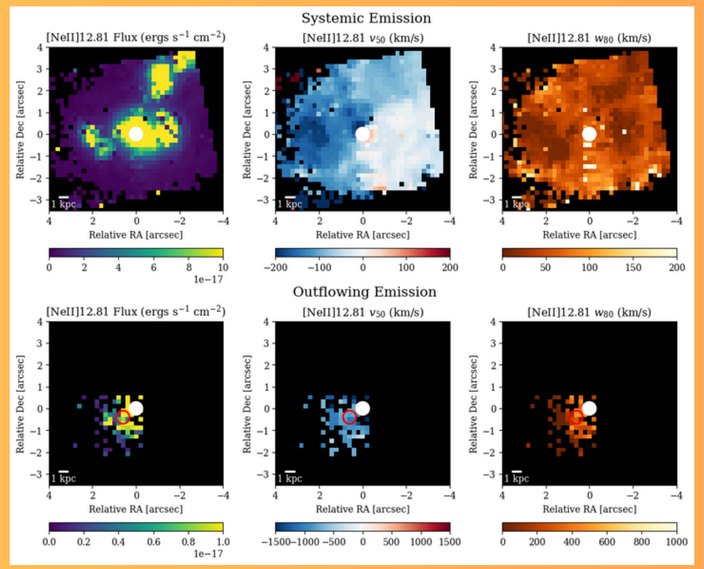
To explore the JWST MIRI data of F20100-4156 to **search for the effects of feedback on the host galaxy**, through MIR tracers of ionized gas (e.g. [Ne II]), molecular gas (e.g. H_2 S(3)), and dust (PAH molecules).

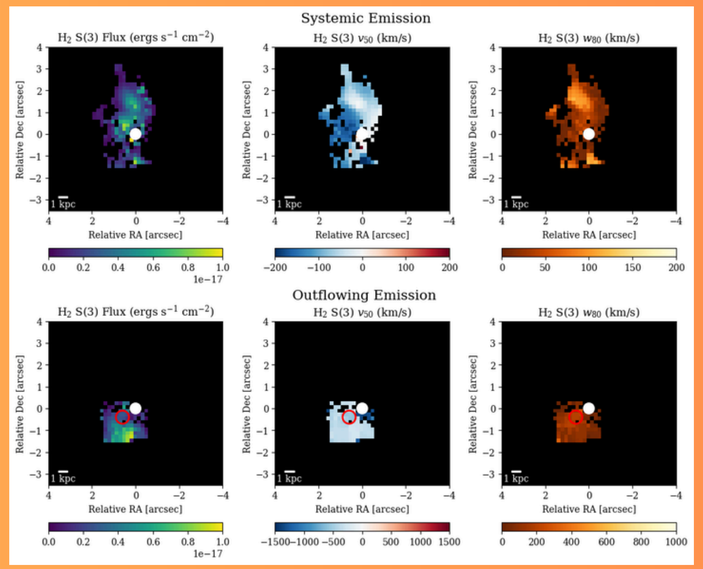
METHODS

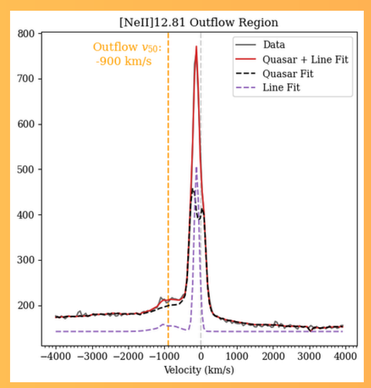
- **Object:** IRAS 20100-4156
- **Instrumentation:** JWST's **Mid-Infrared Instrument (MIRI)**
- **Data:** **Integral Field Unit (IFU)** data cubes
- **Analysis:**
  - The object was visually explored using QFitsView to identify key features.
  - Emission lines **[Ne II]** and **H_2 S(3)** trace warm ionized and warm molecular gas phases, respectively.
  - q3dfit, a python-based fitting software, fit the data cubes **[9]**.
  - q3dfit is specialized for galaxies with bright AGN, as it first removes the bright point spread function (PSF) caused by the central AGN emission before fitting the fainter emission from the host galaxy.
  - We fit the emission lines with either 1 or 2 Gaussian components.
  - The outputs are the flux, v_{50} (median velocity), and w_{80} (velocity width containing 80% of the total flux) values for each spaxel. We turned the outputs into maps to visualize the entire cube for both components.

RESULTS & DISCUSSION

- We see clear evidence for a **rotating galactic disk** from the systemic emission of [Ne II] which displays a relatively low velocity (v_{50} ~ ±200 km/s) gradient from the northeast (blue) to the southwest (systemic). [NeII] exhibits a more extended contribution in the rotating disk than H_2 S(3), especially to the southwest.
- In both lines we see evidence for a **high velocity outflow component blueshifted up to -1500 km/s**. The outflow in [NeII] shows higher velocities than H_2 S(3) v_{50} ~ 900 and 500 km/s, respectively. These outflows are co-spatial in the southeast direction and are detected perpendicular to the disk rotation
- Given the outflows' broader line widths, as indicated by the w_{80} maps, the gas is more turbulent than the disk.



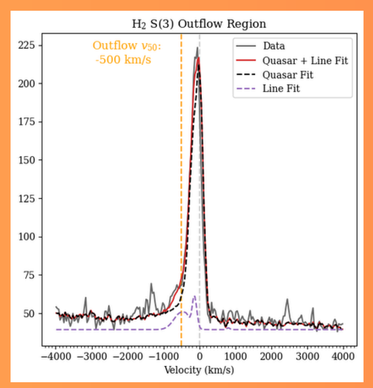




- Closed white circle: AGN; center of ULIRG
- Open red circle: extraction region

CONCLUSION/NEXT STEPS

We explore MIRI observations of ULIRG F20100-4156 and report the **discovery of a AGN driven, high velocity, co-spatial outflow in warm ionized and warm molecular gases**. In the future we plan to continue to paramaterize the nature of this outflow through mass and temperature diagnostics.



Acknowledgements:
I would love to thank Kylie, Jerome, and Sylvain for being patient and informative mentors.

References:

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