EXPLOITING JWST NIRCam WFSS TO MAP ICES IN MOLECULAR CLOUDS

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OVERVIEW

Aim: To spatially map the column density distribution of the three major solid-state species (H_2O, CO_2 and CO) on lines of sight towards star-forming regions in our galaxy.

- Ices → largest reservoir of molecular material in interstellar environments.
- Ices influence the feedback and evolutionary processes involved in star and planet formation.
- JWST → observations in the Near Infrared (NIR) with unprecedented resolution along with spatial and spectral sensitivity.
- My research focus → observations with the Near Infrared Camera (NIRCam) instrument, in WFSS (wide field slitless spectroscopy) mode. (GTO #1187 PI K Hodapp), focused on three molecular clouds at different evolutionary stages, ranging from a pre-stellar collapsing core to an embedded protostellar object (i.e. LDN-694-2 , B68, and B335).
- Poster focus → methodology and first ice-mapping results for B335 (see Figure 1).

Figure 1: Composite JWST NIRCam image with F444W (red), F356W (green) , and F277W (blue) of B335, showing the Class-0 protostar, shadow of the disk and outflow lobes. [1]

METHOD

- B335 observed in both imaging filters and spectroscopy filters covering H_2O, CO_2 and CO ice features.
- Poster focus: F410M, F430M, F460M and F480M on module A (see Figure 2).
- Data reduction (Figure 3);
  (a) Source catalogue generated from imaging
  (b) Sources matched to dispersion traces on grism imaging frames.
  (c) OU_WFSS code used to extract flux vs wavelength data for each source from each frame, recombine to generate source spectrum (and flux error).
  (d) Baseline fitting to generate optical depth spectrum.
  (e) Integration between limits of spectral feature to generate ice column density.
  (f) Column density distribution plotted as f(RA, DEC) to generate ice map.

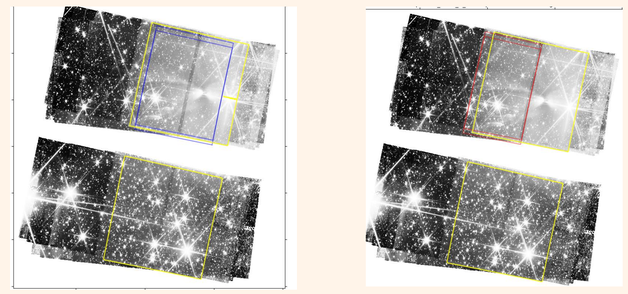
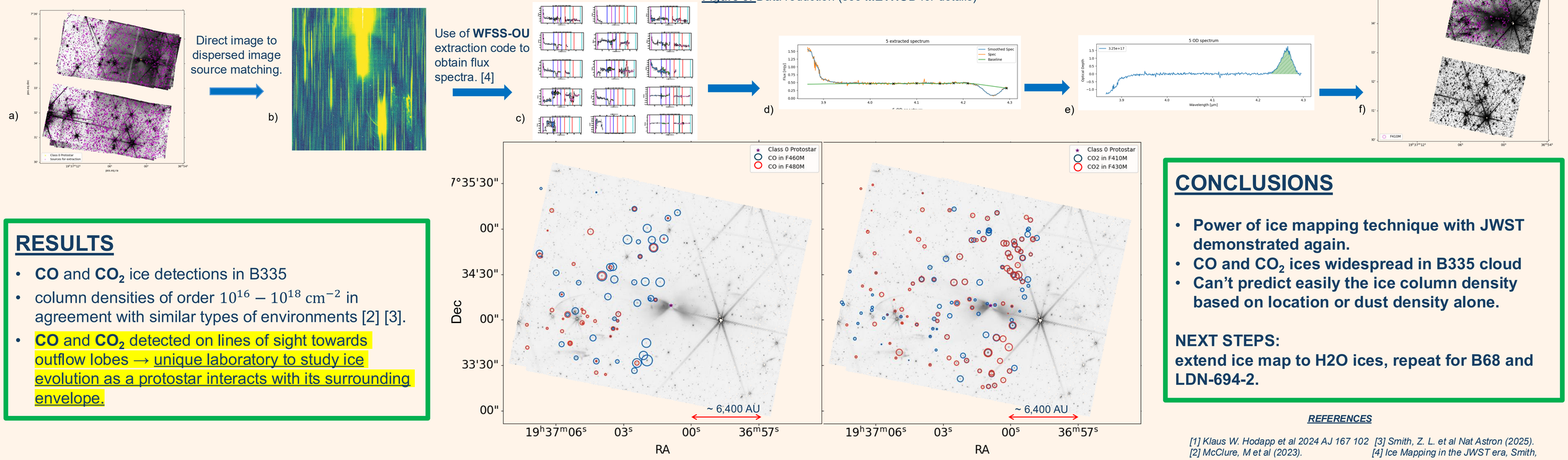


Figure 2: Full filter coverage regions of the two filters F410M and F480M that capture the CO and CO2 ice features in B335.

Figure 3: Data reduction (see **METHOD** for details)



RESULTS

- **CO** and **CO_2** ice detections in B335
- column densities of order $10^{16} - 10^{18}$ cm^{-2} in agreement with similar types of environments [2] [3].
- **CO** and **CO_2** detected on lines of sight towards outflow lobes → unique laboratory to study ice evolution as a protostar interacts with its surrounding envelope.

CONCLUSIONS

- **Power of ice mapping technique with JWST demonstrated again.**
- **CO and CO_2 ices widespread in B335 cloud**
- **Can't predict easily the ice column density based on location or dust density alone.**

NEXT STEPS:
extend ice map to H2O ices, repeat for B68 and LDN-694-2.

REFERENCES

[1] Klaus W. Hodapp et al 2024 AJ 167 102
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[3] Smith, Z. L. et al Nat Astron (2025).
[4] Ice Mapping in the JWST era, Smith, thesis (2024)