ESO observing programme:

The APEX Large CO Heterodyne Outflow Legacy Supercam survey of Orion (ALCOHOLS)

Abstract

This release contains wide-field spectral line imaging data cubes in the ^{12}CO (J=3-2) line at a frequency of 345.795990 GHz. The data were recorded using the SuperCAM 64-pixel heterodyne array camera at the APEX telescope in December 2014. The cubes cover a total area of ~2.7 square degrees in the Orion A and B giant molecular clouds; the frequency axis includes the full spectral extent of the CO line detected in the area, including high-velocity line wings from protostellar molecular outflows. The data reveal a wealth of cloud structures and allow for an unbiased search for protostellar molecular outflows over a large portion of a star-forming cloud. A full presentation of the data has been published in Stanke et al. (2022, A&A 658, A178).

Overview of Observations

We observed four individual fields in the southern part of the Orion A cloud (L1641S-1, L1641S-2, L1641S-3, and L1541S-4, merged into a single final data cube: L1641-S) and six individual fields in Orion B: L1622, NGC2071 and NGC2068 (merged into a single data cube: N2068N2071), Ori B9, and NGC2023 and NGC2024 (also merged into one final cube: N2023N2024). The location of the survey fields are indicated in Fig. 1, and the field centers are given in Tab. 1. In total 51 hours of telescope time were spent on this project, including all overheads.

Several coverages were taken of each field in the 'On-The-Fly' (OTF) mapping mode. Each coverage consists of a series of parallel scan rows, separated by half the array footprint size between rows. The scan direction was alternated between east-west and north-south between individual coverages. Reference spectra towards emission-line free positions off the cloud were taken after every one or two scan rows to allow for subtraction of the sky emission. The rotation of the array orientation with changing hour angle during the observations along with the alternating scanning directions yields a fairly uniform coverage, compensating for the gaps between individual pixels of the array, missing pixels, and differences in sensitivity and noise between pixels. Along the rows, spectra were read every 0.5 seconds, spaced by 6" (~1/3 of the main beam HPBW), corresponding to a scanning speed of 12"/second. Hot-Sky-calibrations were taken every 3-4 scan rows, pointing was checked about once per hour, and focus was checked at the start of each observing session.

Weather conditions were fair throughout the observations, with precipitable water vapour (pwv) ranging between 0.5 mm and 2.2 mm, corresponding to zenith opacities at 345.6 GHz between 0.1 and 0.35. For more details see Stanke et al. 2022.

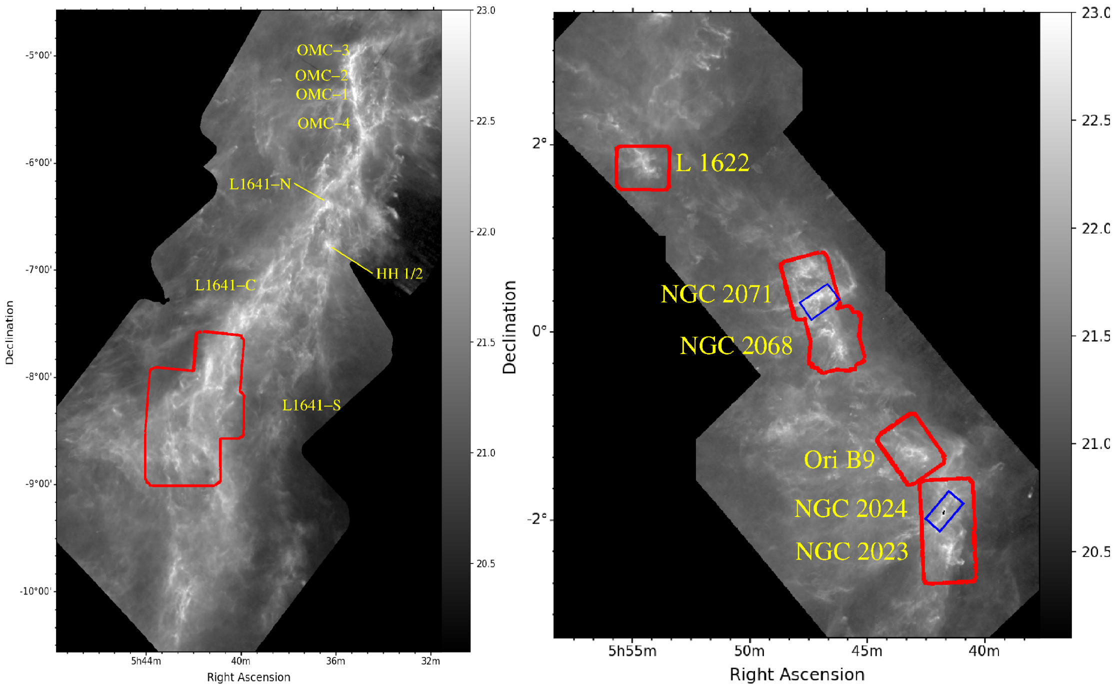

Fig. 1: Outline of the survey fields in Orion A (left) and Orion B (right). Greyscale: column density maps ($log(N_{H2})$) derived from Herschel dust continuum maps. The outlines of the survey fields are marked in red.

Release Content

Fieldname	R.A. (J2000)	Dec. (J2000)	Observing Dates (Dec. 2014)	Exposure time (h)	rms (K, 0.25km/s resolution)
L1641S	5:42:00.0	-8:20:00	14,19, 20, 23-25	13.1	1.14
L1622	5:54:30.0	+01:45:10	23	2.0	1.21
N2068N2071	5:46:52.7	+00:12:35	11, 12, 14, 17, 19	8.5	1.10
ORIB9	5:43:08.0	-01:14:30	22, 23	3.0	1.19
N2023N2024	5:41:32.0	-02:07:00	20-22, 24	8.8	1.03

Table 1 above provides the location of each of the five survey fields (with the spatial coverage indicated in Fig. 1), the dates the fields were observed, the total on-source exposure time per field, and the typical rms achieved (full noise cubes are included in the release, see below).

Release Notes

Data Reduction and Calibration

We provide here a short summary of the data reduction procedure. For full details see Stanke et al. 2022.
Sky subtraction (using integrations on emission-line free OFF positions) was performed on-the-fly during the observations. Amplitude calibration of the spectra was performed using the Hot-

Sky calibrations taken during the observations (using the commonly used APEX on-line calibrator software) for a central 'fiducial' pixel and then transferred to the remaining working pixels through 'gain arrays'.
For the following processing steps we used the GILDAS/CLASS software (*http://www.iram.fr/IRAMFR/GILDAS*) and ESO MIDAS for the additional flatfielding. After identifying defunct and noisy pixels (typically leaving ~44 of the 64 pixels) an iterative procedure was applied to subtract residual spectral baselines left from the sky subtraction and to identify and remove spikes from the spectra. Residual pixel-to-pixel sensitivity variations (causing noticeable striping in the resulting cubes) were accounted for by an additional flat-fielding step. Finally, a mean main beam efficiency of 48% (derived from OTF maps of Jupiter and Saturn) was applied. We then created cubes at a velocity resolution of 0.25 km/s and with a spatial pixel size of 6", over a velocity range wide enough to include the full extent of the CO emission and 10-20 km/s beyond on each side. In order to remove residual baseline instabilities, a final round of spectral baseline removal was performed on the cube.

Data Quality

The accuracy of the flux calibration was checked against observations of a small subfield in the NGC 2023 region (Sandell et al. 2015, A&A 578, A41) taken at APEX with the FLASH+ receiver at the same frequency, finding excellent agreement (to better than 1% when comparing the integrated flux over the subfield). Pixel-to-pixel fluxes also compare well after convolving the FLASH+ maps to slightly poorer angular resolution, indicating a wider beam for the SuperCAM maps, most likely due to the more complex optics system used for that instrument (see Stanke et al. 2022 for more details).
We assessed the rms noise achieved and its uniformity by measuring, for each spatial pixel of the cube, the rms in the emission-line free region of the spectrum. The typical rms for the different fields ranges between ~0.7 to ~0.8 K (where the southernmost subfield in the L1641-S cube has lower coverage and correspondingly higher rms of ~1 K). Pixel-to-pixel variations in the rms are of the order of 0.1 K (see Stanke et al. 2022 for more details).

Known issues

None

Previous Releases

None

Data Format

Files Types

For each of the survey fields the following three files are included in the release (where 'fieldname' takes the values given in Tab. 1, first column):

- [fieldname]_3DcubePh3.fits: main fits data file including the 3D data cube and corresponding error cube as first and second extension, respectively.
- [fieldname]_3DcubePh3_whitelight.fits: integrated intensity map obtained by collapsing the 3D data cube along the spectral axis.
- [fieldname]_3Dcube_GILDASformat.lmv: original 3D data cube in the IRAM GILDAS native .lmv format, to allow for easy re-import and further processing in that environment.

Acknowledgements

When using this data please refer to the following publication:

Stanke, Th.; Arce, H. G.; Bally, J.; Bergman, P.; Carpenter, J.; Davis, C. J.; Dent, W.; Di Francesco, J.; Eislöffel, J.; Froebrich, D.; Ginsburg, A.; Heyer, M.; Johnstone, D.; Mardones, D.; McCaughrean, M. J.; Megeath, S. T.; Nakamura, F.; Smith, M. D.; Stutz, A.; Tatematsu, K.; Walker, C.; Williams, J. P.; Zinnecker, H.; Swift, B. J.; Kulesa, C.; Peters, B.; Duffy, B.; Kloosterman, J.; Yıldız, U. A.; Pineda, J. L.; De Breuck, C.; Klein, Th. 2022, A&A 658, A178 (2022A&A...658A.178S)

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