1. *Tending the Fire: A Legacy Survey of Molecular Gas Fueling in Powerful Nearby AGN*

● Abstract

This data release contains APEX/SHFI CO(2-1) spectra from a sample of 165 nearby ($0.01 < z < 0.05$) hard X-ray selected AGN galaxies. The low redshift limit was chosen to ensure that the emission is not extended beyond the 28" APEX beam size, while the upper redshift limit was to ensure detectability in a reasonable amount of observing time. The parent sample is the 70-month catalog of Swift's Burst Alert Telescope (BAT). The targets are spread over a large part of the sky to ease the observability. The main science goal of the survey was to determine the molecular gas content of these AGN-selected galaxies, and compare them with similar CO(2-1) galaxies from field samples. While this programme was mainly aiming at a statistical sample, many of the galaxies observed are well-known galaxies, and these phase 3 data can provide a valuable total power measurement of the CO(2-1) which can be combined with interferometric observations obtained with ALMA.

The observations were obtained as part of a joint ESO (198.A-0708 PI Mike Koss) and Chilean (097.F-9705 PI Ezequiel Treiser) large programme. For observing efficiency, the observations were mostly done from the Chilean project 097.F-9705(A), but additional observations were also obtained in a follow-up ESO programme (0100.A-0384 PI Benny Trakhtenbrot) as well as from several archival projects.

● Overview of Observations

APEX 12 m antenna observations were taken for 165 AGN galaxies, comprising multiple 400-second-long scans, with a 100" throw between the ON and OFF-beam. The program totalled 254 hours with 2288 scans, taken over 67 days between 2016 March and 2017 September. Observing conditions had Precipitable Water Vapour (PWV) ranging from 0.4–4.5 mm with a median of 1.5 mm. CO(2–1) transitions ($\nu_{rest}=$ 230.538 GHz) were observed using the Swedish Heterodyne Facility Instrument (SHFI; Vassilev et al. 2008 A&A 490, 1157) with the eXtended Fast Fourier Transform Spectrometer (XFFTS) backend (213–275 GHz), tuned to the source-specific redshifted CO line frequencies. At the observed frequencies ($\sim$216–229 GHz), the APEX effective primary beam size is 27.4"– 28.4" half power beam width (HPBW), corresponding to scales between 6–27 kpc at the distances of our sources. Observations were terminated either after (1) a 5-σ line detection was reached, (2) $\sim$3 hours of observations (including overheads; i.e., 40 minutes on-source), or (3) a sensitivity of 1 mK rms in the antenna

temperature scale ($T_A{}^*$) (corrected for atmospheric attenuation, the forward efficiency, and signal band gain) in a 50 km s^{-1} channel was reached (whichever criterion came first). This resulted in either detections or non-detections with rms in the range 0.5 to 2 mK. In addition to the data that we obtained in the project, we have added APEX data from the ESO archive.

● Release Content

The individual spectra use the target name selected by the PI following the APEX phase 2 constraints (maximum 12 characters). For each object, a single combined spectrum is provided.

● Release Notes

Data Reduction and Calibration
Data Reduction: The data were reduced using CLASS, a package of the GILDAS software released by IRAM. Each scan was examined by eye. On average, about 10% of the individual scans of each target were discarded, and in extreme cases up to 50% of the scans. Flux densities were derived assuming a constant conversion factor of 39 Jy beam^{-1} K^{-1} for the APEX telescope.

Data Selection: Observations were terminated either after (1) a 5-σ line detection was reached, (2) ~3 hours of observations (including overheads; i.e., 40 minutes on-source), or (3) a sensitivity of 1 mK rms in the antenna temperature scale ($T_A{}^*$) (corrected for atmospheric attenuation, the forward efficiency, and signal band gain) in a 50 km s^{-1} channel was reached (whichever criterion came first). Data were rejected if they had baseline ripples that clearly do not originate from astronomical sources; or strong artifacts at the edge of the spectral range ($\pm$1000 km s^{-1})

Data Quality
All data were calibrated using frequent hot/cold/sky calibration scans, as per standard APEX procedures.

Known issues
None known

Previous Releases
None

● Data Format

Files Types

This release contains one-dimensional spectra in FITS binary spectroscopic data format,[1] containing a single reduced galaxy spectrum each. The original files are named 'SOURCE_1DspecPh3.fits', where the 'SOURCE' name matches the name as provided during the phase 2 submission (maximum 12 characters). The original file names of the products are recorded in the primary headers of the files in keyword ORIGFILE.

File structure

The files come as binary FITS tables in multi-column format. The columns are labelled as:

FREQ Frequency in gigahertz
FLUX Flux in janskys
ERR   Flux error in janskys

● Acknowledgements

Any publication making use of these data, whether obtained from the ESO archive or via third parties, must include the following acknowledgment:

Based on data products created from observations collected at the European Organisation for Astronomical Research in the Southern Hemisphere under programmes E198.A-0708(A) and C097.F-9705(A).

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[1] https://www.eso.org/sci/observing/phase3/p3sdpstd.pdf