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# The Forgotten Quadrant Survey

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**Abstract.** The Forgotten Quadrant Survey (FQS) is an ESO large project at the 12-m Kitt Peak antenna of the Arizona Radio Observatory with the aim to map the Galactic Plane in the range 220°< $l$ <240° and 0°< $b$ <-2°, both in $^{12}$CO (1-0) and $^{13}$CO (1-0). FQS will produce a dataset of great legacy value, largely improving the data quality both in terms of sensitivity and spatial resolution over existing datasets, in this poorly studied portion of the outer Galaxy. FQS contributes to the general effort to produce a new generation of high-quality spectroscopic data for the Galactic Plane. Such data, in conjunction with the latest generation continuum surveys, will produce a new and more detailed picture of the plane of the Milky Way.

## 1. Introduction

The most recent continuum and spectroscopic surveys of the Galactic Plane have reached an ideal compromise between sub-arcminute spatial resolution, sensitivity and large spatial coverage, allowing the simultaneous study of dense structures from single star forming object/system to entire spiral arms. The Forgotten Quadrant Survey (FQS) is one of the new generation surveys of the Galactic Plane, that provides high-quality spectroscopic data for the molecular component of the Galactic Plane from which essential information, such as distance and gas kinematics, can be derived.

We used the Arizona Radio Observatory AEM ALMA prototype 12-m antenna with the ALMA Type Band-3 Receiver to map the Galactic Plane in the range 220°< $l$ < 240° and 0°< $b$ < -2°, following the Galactic warp, both in $^{12}$CO (1-0) and $^{13}$CO (1-0). The coverage of survey the area is organised in tiles of 30′×30′ size. Each tile is observed twice in mutually orthogonal scan directions to minimize the 1/f noise and eliminate systematics. We use the On The Fly observing mode with scanning speed of 75″/s and Nyquist spatial sampling. The backend is composed of a 256 channel filter bank at 250 KHz spectral resolution (corresponding to a velocity resolution of 0.65 kms$^{-1}$), in parallel with a second 256 channel filter bank at 100 KHz spectral resolution (corresponding to a velocity resolution of 0.26 kms$^{-1}$). The rms noise for spectra resampled to 1 kms$^{-1}$ ranges from 0.7 K

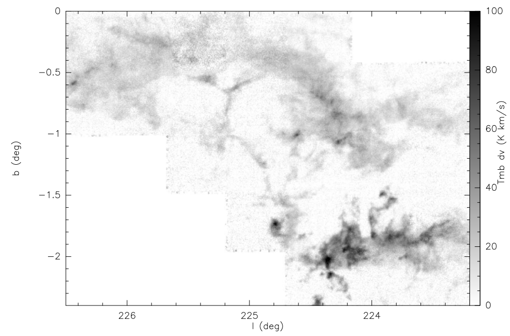


**Fig. 1.** $^{12}$CO (1-0) map integrated over the velocity range (8–24) kms$^{-1}$ of a portion of the mapped area.

to 1.2 K for $^{12}$CO (1-0) and from 0.17 K to 0.45 K for $^{13}$CO (1-0). Calibrated spectra were processed with a pipeline that finally generates spectral cubes covering two areas of about 10°×2° each. An example of the integrated intensity map of $^{12}$CO (1-0) is shown in Fig. 1.

## 2. Scientific goals

The main scientific goals of the survey are the following:

- *To get a better understanding of the large-scale structure in this portion of the outer Galaxy, with improved spatial resolution.* FQS data will allow the identification of molecular clouds, distinguishing clouds at different distance along the same line of sight. The simultaneous observation of the $^{12}$CO and $^{13}$CO isotopologues will allow to compute a reliable estimate of the CO column density and mass for each cloud.
- *To produce a catalog of filamentary structures and to investigate their formation mechanism.* FQS data will be used to verify whether the filamentary structures identified in the Hi-GAL photometric maps (Schisano et al, in preparation) are really kinematically coherent structures. For these filaments the velocity gradients will be measured, allowing the study of feeding mechanisms.
- *To produce a catalog of dense cores and to build the Core Mass Function.* FQS data offer the possibility to measure the non-thermal contribution to the line broadening and therefore to measure the virial mass of dense cores and clumps from which their gravitational state (bound or unbound) can be derived. This is of crucial importance for distinguishing structures that may eventually form a star or a multiple system of stars, from those which will disperse and therefore for building a correct Core Mass Function.
- *To derive distance estimates for the dense compact sources detected in the continuum far-infrared maps.* FQS data will provide the $v_{lsr}$ of the gas from which the distance can be derived by assuming a Galactic rotation model. In particular, distance estimates will be derived from the FQS data for Hi-GAL sources in this part of the Milky Way (Merello et al., in preparation).

## 3. Final products

The scientific products of the survey are publicly available. Raw data are accessible at the URL *http://fqs.iaps.inaf.it*. Advanced products such as spectral cubes of about 10°×2° with first and second moments maps will be delivered by the end of 2017. We also foresee to produce catalogues of compact sources and filamentary structures. FQS products will be made available to the community in the framework of the VIALACTEA knowledge-base (Molinari et al., 2016) that allows the inspection of the data in combination with continuum and spectroscopic data of the Galactic Plane from surveys at many wavelengths from infrared to radio frequencies.

## References

Merello, M., et al., in preparation
Molinari, S., et al., 2016, Proceedings of IAU Sym. 325, eds. M. Brescia et al., p. 291
Schisano, E., et al., in preparation