Better Science Through an Enhanced User Interface with the ALMA Archive

Powering metadata-driven queries

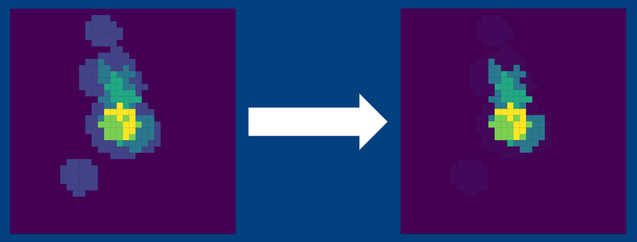
António Dias, Israel Matute, Sara Madeira, Ciro Pappalardo, José Afonso

Introduction

The Atacama Large Millimetre Array, located on the homonymous Chilean desert, is the largest interferometric telescope in the world. Observing radiation in the millimetre and sub-millimetre regions of the electromagnetic spectrum, ALMA offers unprecedented resolution and image solving capabilities that have been explored by a diverse and ever-increasing scientific community studying extragalactic structures, dust cloud emissions, Solar System bodies and stellar formation, among others.

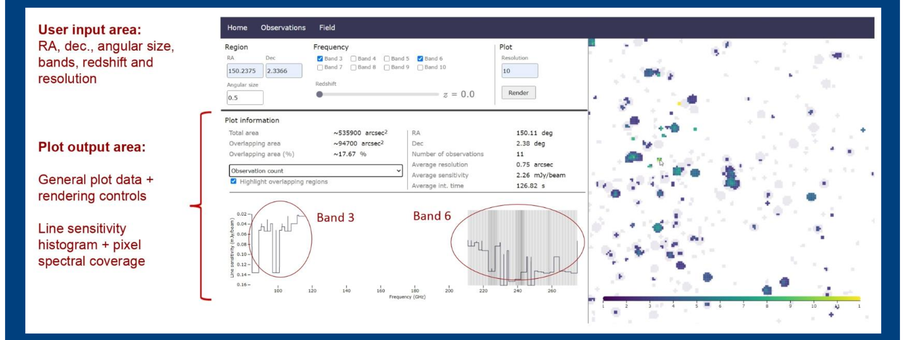
Image credit: European Southern Observatory

Access to ALMA data is primarily done through the ALMA Science Archive, a web-based tool that allows both amateur and expert users alike obtain information on the observatory's +44000 observation set by filtering through their spatial location, frequency coverage, emission lines, sensitivity and so on. Despite offering a plethora of features and information pertaining to ALMA observations, it is understood that the Archive could be improved with external tools that, apart from increasing public engagement by offering a more robust and appealing visualization component, can also guide the user in new ways to tap into the hidden potential of ALMA data through combining overlapping observations. This poster describes an ongoing project that aims to develop such a tool.



Overlapping area between a group of observations

The project

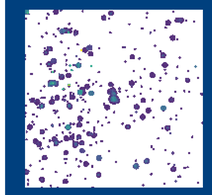


A screenshot of the plotting tool user interface, showing the input area, the plot itself, a per-pixel frequency coverage histogram and rendering controls. Demonstration video found here

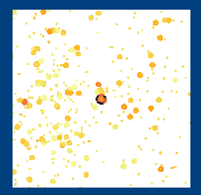
The web service, built on the Django framework, has been designed around two main tools, each facilitating data exploration on a specific level:

- Full-sky plots that highlight dense observation clusters and other trends
- Regional plots that analyse observations on a per-pixel basis, showing areas where observations overlap and their respective frequency coverage, combined sensitivity and other measurements.

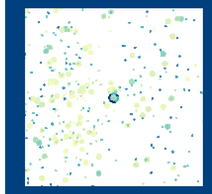
Regional plots (COSMOS field, bands 3 and 6)



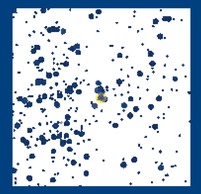
Observation density



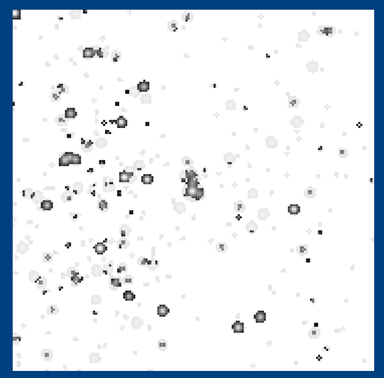
Avg. resolution



Avg. line sensitivity



Avg. int. time

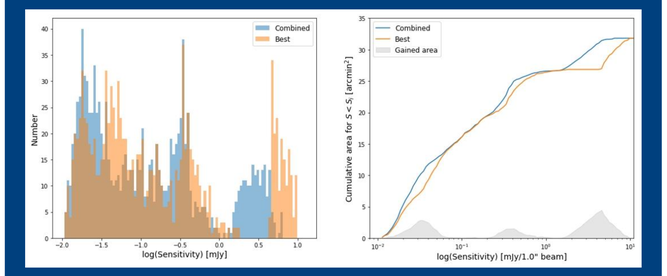


Sensitivity improvement factor through data combination, highlighting overlapping pixels

Data combination

By combining two or more different observations, it is possible to obtain images with better sensitivity that each could provide individually. The line sensitivity of an observation can be approximated by a Gaussian function, the parameters of which depending primarily on the used arrays but also, for instance, the observed frequency.

It is important that the user is able to obtain an estimate of what can be achieved through data cube combination, which can be done just by resorting to the observations' metadata without need for the cubes themselves. The following graphs represent such an estimate for a region within the COSMOS field on band 3. Left side is the total number of pixels, and the right histogram highlights the gained area for different sensitivities:



Sensitivity improvement factors obtained for a pixel size of 10 arcsecs and beam sizes scaled to 1". Mosaic information included. Mean improvement of 1.8±0.3. Data taken from the previous regional plots.

Acknowledgements

This work is supported by Fundação para a Ciência e a Tecnologia (FCT) through the research grants UIDB/04434/2020, UIDP/04434/2020 and PTDC/FIS-AST/29245/2017

COFINANCIAMENTO COFINANCING
FCT Fundação para a Ciência e a Tecnologia
COMPETE 2020
PORTUGAL 2020
UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional