Uncovering Early Galaxy Evolution in the
ALMA and JWST Era
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Preliminary results from prebiotic molecules with ALMA in the era of artificial intelligence

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Abstract. Study of the composition from diverse sources of the Universe helps to us to understand their evolution. Molecular spectroscopy provides detailed information of the observed objects. We present a small study of the starburst NGC 253 with ALMA at 1mm. We detect the prebiotic molecules NH_2CHO, and CNCHO. We obtain the integrated intensity maps and abundances of HNCO, CH_3OH, H_3O+ and CH_3C_2H. We propose the use of Artificial Intelligence for big data to find prebiotic molecules in galaxies.

Keywords. ALMA, Molecules, Spectroscopy, Artificial Intelligence.

1. Introduction

The starburst NGC 253 is at a distance of 3.5 Mpc (Rekola 2005) and has a velocity of 258.8km/s. It is one of the brightest extragalactic molecular line sources. Sakamoto *et al.* (2011) studied NGC 253 and identified five peaks (Clumps) at 1.3mm of molecular line and continuum emission over 300pc. Meier *et al.* (2015) did an ALMA multi-line study of NGC 253 which confirmed molecules previously detected at 3 mm as well as reporting the new tentative detection of molecules previously not observed. Ando *et al.* (2017) et al. observed the same source but in the range centered at 0.85mm. They resolved the nuclear starburst in 8 clumps separated 10 pc in scale, detected complex organic molecules, and found that the hot and chemically rich environments are located within 10pc of the nucleus. Villicana-Pedraza *et al.* (2017) studied the same galaxy at the same frequency but using a single dish.

We report here some results centered at 307GHz observed with ALMA (PI. Villicana-Pedraza No. 2013.1.00973).

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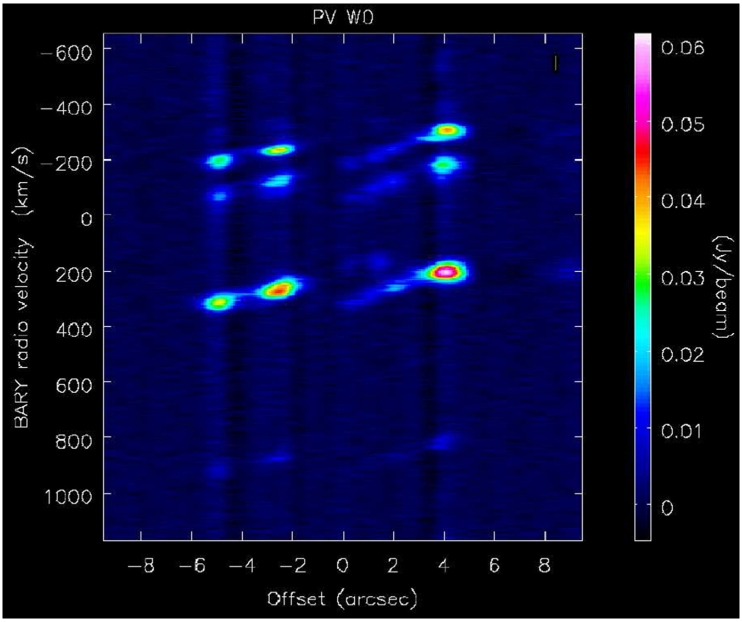

Figure 1. Position-Velocity diagram for the spectral window from 306-308GHz.

2. Analysis and Results

We re-reduced all the observations with the Common Astronomy Software Applications package (CASA). A calibration and the subsequent image extraction of the data cubes were performed. The analysis was carried out using CASA, with GILDAS being preferred for some images. The continuum emission from NGC253 has a flux density of approximately 1 Jy at 294.96GHz. The primary beam has a FWHM of 17.6 arcsec. We identified four clumps in the continuum.

We made Position Velocity maps (P-V) to identify the molecular features of the region and identify blended lines. From the P-V maps we established that the region studied contains features of 4 molecular lines that belong to HNCO, CH_3OH, H_3O+ and CH_3C_2H.We found CH_3C_2H blended, therefore we used a mask of HNCO to separate them (Fig. 1). We obtained integrated intensity maps, column densities and abundances for these molecules. We found one transition for the prebiotic molecules NH_2CHO, and CNCHO; we confirm the tentative detections from Meier *et al.* (2015). We also observed CH_3CH_2OH. The tables with the abundances and maps can be found in Villicana-Pedraza *et al.* in prep.

3. Artificial Intelligence and Machine Learning applications

In this work we report the detection of 2 prebiotic molecules toward one starburst galaxy. Villicana-Pedraza (2017) reported one more detected in a Seyfert galaxy. We will create templates of all molecular lines likely present in galaxies to help the search for prebiotic molecules. The ultimate goal is to establish the environments in which these lines are formed and obtain their abundances. To achieve this goal we will use Artificial Intelligence (AI) and Machine learning (ML) to analyze data for hundreds of galaxies. AI and ML can analyze information much faster than conventional techniques. We can implement an ML algorithm in Python in two stages: The first one is using a Decision Tree Algorithm with the task DecisionTreeClassifier(); The second is to train data sets for the fitting process for the abundances.

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