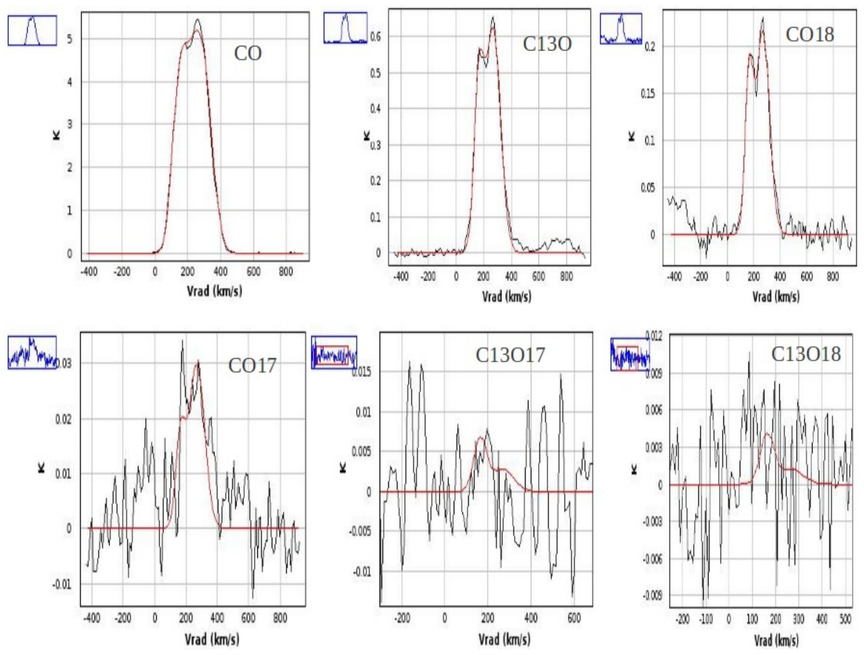
Molecular Study of CO in near galaxies:
NGC 253 and NGC 4945 case.

Villicaña Pedraza I., Martín-Pintado J., Requna-Torres, M & Güsten R.
Cento de Astrobiologia (CSIC-INTA), Torrejon de Ardoz Madrid.
Max-Planck Institute für Radioastronomie, Bonn, Germany

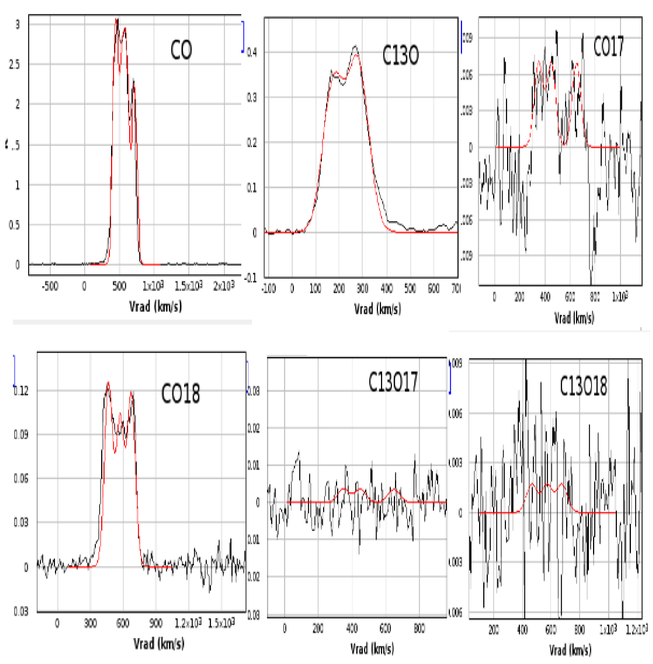
ABSTRACT: In this work we present the preliminary analysis of the CO emission and its isotopologues 13CO, 17CO,18CO, 13C17O and 13C18O toward the nearby galaxies NGC 253 and NGC 4945 obtained from the full spectral scan surveys in the 345 GHz atmospheric window with the APEX Telescope located at 5100m on the Chajnator Plateau at Atacama, Chile. We derived isotopic ratio 12C/13C in starburst galaxies much higher (> 40 and >90) than those in the nucleus of the Milky Way nucleus (22), indicating that interstellar matter has undergone different processing histories. There are two possible explanations: nucleosynthesis differences due stellar population history and/or accretion of matter from the halo.

INTRODUCTION: Martín et al. (2006) carried out the first survey of molecular emission toward an extragalactic source – NGC 253 in the 2mm atmospheric window. Wang et al. (2004) worked in a study of NGC 4945 of selected molecules with transitions at 3 mm and 1.3mm; Riquelme et al. (2010) studied the properties of gas in the galactic center using isotopic ratios. They found that the gas in the halo showed larger 12C/13C ratios of 70 than in the disk of 22. Martin et al (2004) have used CCH to show that the the 12C/13C ratio in the the sturbust galaxies NGC253 and M82 are much larger (>90) than that found in the nucleus of the Milky Way.

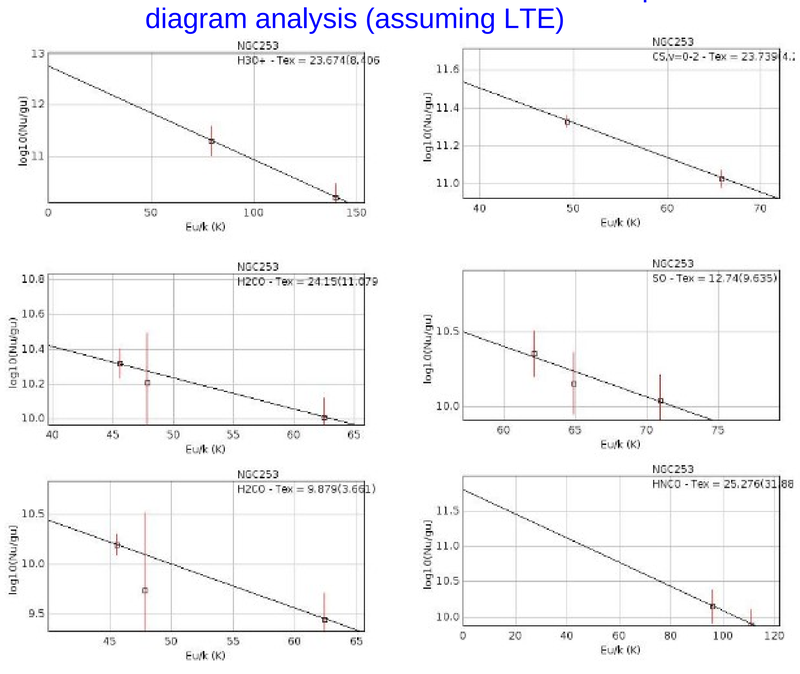
NGC253



NGC4945



ROTATIONAL DIAGRAM- NGC253: Population diagram analysis (assuming LTE)



METODOLOGY

We detected 54 lines in NGC 253 and 46 lines in NGC 4945 with the APEX radiotelescope from 280 to 370 GHz for NGC 253, and from 270 to 375 GHz for NGC 4945. We got an average spectra for each galaxy. We used MADCUBAIJ to identify molecular lines and fit gauss line profiles to the spectra of CO and its isotopologues. Based on the fitted parameters we calculated column density for CO and isotopologues using the MADCUBAIJ LTE analysis. From the column densities we obtained the isotopic ratios. Finally, we identified and analyzed other molecular lines in NGC253 from HNCO, SO,CCH, H2CO,HOCO+, CS33, CS,HCO+, HCN, HNC, CN, N2H+, H3O+, NO and CH3OH; We compared the results with 2mm survey by Martín et al. (2006) and found similar rotational temperatures.

RESULTS

Parameters obtained from NGC253 galaxy for co and its isotopes. There are two components for each molecule, Tex=24.7K and Tex=15.2 respectively.

Formula	Width(km/s)	Velocity(km/s)	DensCol(cm^{-2})	ratio
CO,v=0	131	215	1.75E17	CO/C13O 9,12
CO,v=0	167	231	8.4E17	
C-13-O	100	173	1,92E16	
C-13-O	105	278	5,92E16	
CO-18	82	179	6,03E15	
CO-18	82	276	1.91E16	
CO-17	81	168	5,73E14	
CO-17	81	276	2,62E15	
C13O17	81	168	2,51E14	
C13O18	82	179	1,02E14	(C018/C13O18) 40

Ratio between C0/C13O (3-2) is 9 in this work, in comparation with Martin et al. 2006 paper they have more than 46 using CCH, it is indicating that in my case 12CO is opaque. In adittion C18O is less opaque. The result is consistent because C18O is less abundant than 13CO.

Parameters obtained from NGC4945 galaxy for co and its isotopes with Tex=10K. There are three componentes for each molecules.

Formula	Width(km/s)	Velocity(km/s)	DensCol(cm^{-2})	ratio
CO,v=0	85	449	5E18	
CO,v=0	85	576	1.5E18	(CO/C13O C2)50
CO,v=0	85	713	1.5E18	
C-13-O	113	679	3.1E16	
C-13-O	160	537	3.0E16	
C-13-O	82	453	3.3E16	
CO-18	86	676	1.8E16	
CO-18	86	573	2.1E16	
CO-18	86	466	1.9E16	
CO-17	80	650	7.9E14	
CO-17	80	450	7.9E14	
CO-17	80	350	7.9E14	
C13O17	80	650	3.1E14	
C13O17	80	450	3.1E14	
C13O17	80	350	3.1E14	
C13O18	87	676	1.9E14	(C018/C13O18)100
C13O18	87	573	1.9E14	
C13O18	87	466	1.9E14	

The equations used in this study are shown below. N is the total column density, Eu energy upper level. Trot the rotational temperature, the partition function Z, Aul Einstein coefficients and W is the integrated area.

$$N_u = \frac{8\pi k\nu^2}{hc^3 A_{ul}} \left(1 - \frac{J_\nu(T_{BG})}{J_\nu(T_{ex})}\right)^{-1} \int T_B \, dv \qquad N_u = \frac{8\pi k\nu^2}{hc^3 A_{ul}} W$$

$$\frac{N_u}{g_u} = \frac{N}{Z} e^{-E_u/kT_{rot}} \qquad N = \frac{8\pi k\nu^2 Z}{hc^3 A_{ul} g_u} W e^{E_u/kT_{rot}}$$

According to the article by Marin et al. 2006 there is not isotopic fraction photodissociation to be detected by various species of Molécules, which is consistent with this work.

Rotational Temperature at 1mm in this work is consistent with which obtained in 2mm shown in Martin et al. 2006.

PRELIMINAR CONCLUSIONS: The isotopic ratio 12C/13Cderived from 13C18O and C18O in the starburst galaxies NGC253 and NGC4945 is larger than that found in the nucleus of the Milky Way. There are two possibilities to explain our results: Differences in nucleosynthesis history due to different stellar population history and/or accretion of matter from the halo.

REFERENCES
Martín et al. Astrophysical Journal Supplement Series, 2006, 450-476, v.164.
Wang et al. Astronomy and Astrophysics, 2004, p.883-905, v.422.
Martin et al. Astronomy and Astrophysics, 2010, A62, v.522.
Riquelme et al. Astronomy and Astrophysics, 2010, A51, v.523.

CENTRO DE ASTROBIOLOGÍA
ASOCIADO AL NASA ASTROBIOLOGY INSTITUTE

GOBIERNO DE ESPAÑA
CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS
INTA Instituto Nacional de Técnica Aeroespacial

MAX-PLANCK-INSTITUT FÜR RADIOASTRONOMIE