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^{12}CO (1-0) AND (2-1) OBSERVATIONS OF ISOLATED EARLY-TYPE GALAXIES

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RESUMEN

Presentamos los resultados de observaciones de ^{12}CO(J=1-0 and 2-1) en una muestra de galaxias tempranas (ETG) aisladas. Las observaciones fueron llevadas a cabo con la antena de 12 m de Kitt Peak operada por los Arizona Radio Observatories (ARO). Un objeto (KIG0137) fue detectado en ambas bandas. Para este objeto estimamos la masa en forma de gas molecular. Estas observaciones son parte de un proyecto cuyo objetivo es complementar las bases de datos existentes para el estudio de efectos ambientales en el medio interestelar de ETG.

ABSTRACT

We present ^{12}CO(J=1-0 and 2-1) observations of a small sample of isolated early-type galaxies (ETGs). The data has been collected with the Arizona Radio Observatories (ARO) 12 m telescope at Kitt Peak. One object (KIG137) was unambiguously detected in both bands. For this detected galaxy we estimate of the molecular hydrogen mass. These observations are part of a larger project aimed at complementing existing data bases for the study of environmental effects on the interstellar medium in ETGs.

Key Words: galaxies: elliptical and lenticular, cD — galaxies: ISM

1. INTRODUCTION

The scenario in which Early-Type galaxies (particularly ellipticals) evolve passively after a single massive burst of star formation and, as a consequence becoming devoid of the ingredients to form new stars, has changed dramatically over the past twenty years. New observational techniques, made possible by the development of new facilities, have shown the presence of non-negligible amounts of interstellar material in these objects, indicating that an interstellar medium (ISM) pervades galaxies of all types, including Es and S0s. Recently, three distinct phases of ISM, detected in different amounts, have been used to characterize the evolutionary stages of galaxies: (i) a cool component (T=100 K), (ii) a warm component (T=10^4 K) and (iii) a coronal gas (T=10^6–10^7 K). In addition, CO has been detected in about 70 of these objects, which suggests the presence of intrinsically cold molecular gas (T=10–20 K).

There are four hypotheses (see review by Knapp 1999) for the origin of the gas: (1) left over from the formation of the galaxy; (2) produced by stellar mass-loss; (3) captured from a companion; and (4) replenished from cooling flows.

Finding wich of those applies requires a large data set. To date, the largest and homonegeous collection of ISM data is that of Bettoni et al. (2003). This database contains ISM information on 1916 ETGs; nevertheless, only 6% have detected molecular gas whereas 54% have detected dust. Consequently, we have conducted observations of ETGs that have evidence of some ISM components other that molecular gas. In this poster paper we present new observations of a sample of early-type galaxies that will complement exiting databases.

2. THE SAMPLE AND OBSERVATIONS

^{12}CO(1-0 and 2-1) observations were carried out in three observing runs at the Arizona Radio Observatories (ARO) 12 m telescope at Kitt Peak in March, April, and May of 2003. Complementary observations were carried out at the FCRAO using the 14 m antenna and will be published elsewhere.

The sample presented here consists of 10 galaxies selected from the Catalog of Isolated Sources (Karachentseva 1973). Four galaxies with previous millimeter-wave observations were also included in the sample for control purposes (reference galaxies). In addition to morphology type, we also constrained the sample by including galaxies with IR fluxes larger than 230 mJy and 700 mJy at 60 and 100 μm, respectively. The sample is listed in Table 1 where columns

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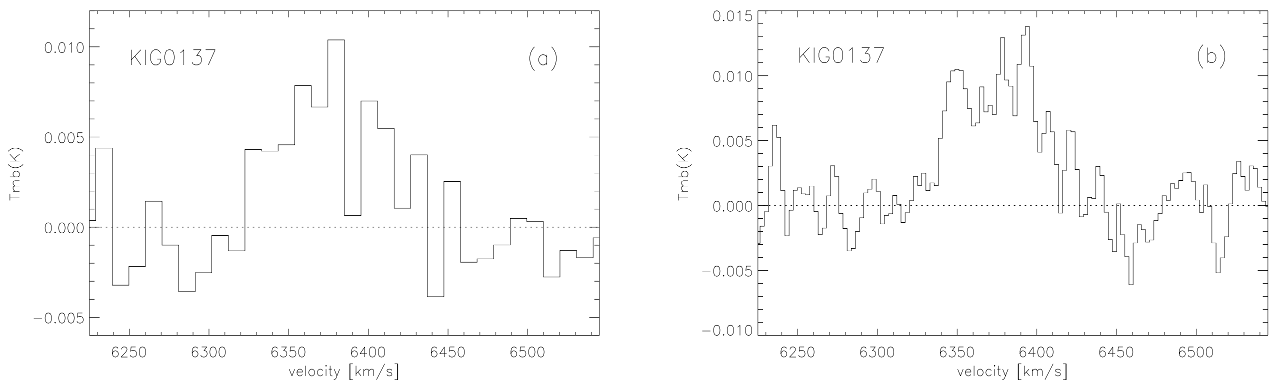

Fig. 1. CO smoothed spectra of KIG0137 from the 12m telescope at Kitt Peak. Panels (a) and (b) display, respectively, the spectra for the ^{12}CO(1-0) and (2-1) transitions obtained with the FB2.

TABLE 1

OBSERVED GALAXIES

Object	Type	Velocity [km s^{-1}]	Dimensions [arcmin]
KIG0020	E	5104	0.7×0.7
KIG0043	E	5016	0.40×0.32
KIG0079	S0	5128	0.4×0.4
KIG0137	S0	6376	0.5×0.5
KIG0332	S0	4316	1.12×0.69
KIG0832	S0	3300	0.40×0.25
KIG0894	E	5095	0.50×0.33
KIG0903	S0	5206	0.63×0.46
KIG1025	E?	3450	0.3×0.3
KIG1032	S0/a	1870	1.14×0.51

(1) to (4) give the galaxy ID, the morphology type, the heliocentric radial velocity, and the projected dimensions, respectively. This information was collected from various sources, mainly from the NASA Extragalactic Database (NED).

The receivers of the 12 m telescope consist of two filterbanks (FB1 and FB2) and a millimeter autocorrelator (MAC) in which objects can be observed simultaneously at resolutions of 2.6, 5.2 and 1.0 km s^{-1}, respectively. Integration times were at least 2 hrs (20 scans of 6 minutes each), The beam sizes of the telescope are $55''$ and $27''$ for 115 GHz and 230 GHz, respectively. During the three runs, system temperatures ranged from 200–600 mK. Data reduction was conducted using the package Continuum and Line Analysis Single-dish Software (CLASS). Spectra were baseline corrected by subtracting baselines that excluded a central window determined by the width of HI emission. When HI data were not available the central 300 km s^{-1} were excluded (for MAC data).

3. RESULTS

Our data reduction delivered one new detection, KIG0137 in both transitions. The results are displayed in Figure 1 were we plot the spectra for the detected galaxy. Spectra correspond to the coadded and smoothed scans collected with the FB2. The ordinate depicts the main beam antenna temperature (Tmb). The rest of the target galaxies were not detected, although two cases can be considered as marginal detections.

The estimation of the molecular hydrogen contents was estimated using the conversion factor of the Milky Way; $\mathrm{NH_2/I_{CO}} = 2.0 \times 10^{20}\,\mathrm{cm^{-2}\,(K\,km\,s^{-1})^{-1}}$, where $\mathrm{I_{CO}}$ is the integrated intensity in CO for the (J=1-0) transition, which has been calculated adopting a main beam efficiency, η_{mb}, of 0.85. The molecular gas mass was computed with the expression $\mathrm{M(H_2)} = 2.52 \times 10^5 \mathrm{D^2_{Mpc}\,I_{CO}}\,M_\odot$, where the distance D was obtained considering a Hubble constant of $\mathrm{H_0} = 75\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$.

The molecular gas mass of KIG0137 is estimated to be $2.8 \times 10^9\,M_\odot$. The analysis of the full sample, which includes members of loose groups, is presented in detail in Chavez et al. (in preparation).

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