Publications of the Korean Astronomical Society
30: 107 ∼ 108, 2015 September

pISSN: 1225-1534
eISSN: 2287-6936
http://dx.doi.org/10.5303/PKAS.2015.30.2.107

CENSUS AND ANALYSIS OF GALACTIC MOLECULAR CLOUDS

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(Received November 30, 2014; Reviced May 31, 2015; Aaccepted June 30, 2015)

ABSTRACT

In this project, all available databases of molecular and gas-dust clouds in the Galaxy were cross-identified by taking into account available properties, including position, angular dimensions, velocity, density, temperature and mass. An initial list of about 7000 entries was condensed into a cross-identified all-sky catalogue containing molecular and gas-dust clouds. Some relationships were studied between the main physical features of clouds. Finally, we prepared a complex observing program and address future work for filling in the gaps.

Key words: Galaxy: structure–Galaxy: disk – Galaxy: kinematics and dynamics - ISM: structure – ISM: clouds - radio lines: ISM - Catalogs

1. INTRODUCTION

At the present time the rapid progress both in instrumentation and observing technology creates conditions for in-depth study of the interstellar medium (ISM) in the Galaxy as well as in other galaxies such as LMC, SMC, M31, M33, M51, M77, M83, M110, IC10, NGC185, NGC1569, NGC2976, NGC3077, NGC4038/9, NGC4214, NGC4449, NGC4605, etc. A significant fraction of the baryon mass of the ISM in the Galaxy and observed galaxies is concentrated in the form of nebula or clouds with molecular content in the densest parts (see, e.g., Draine 2011). Naturally, the molecular clouds (MoC) should be closely related to cold dust-gas clouds, particularly HI ones. They have to play a key-role in the star forming processes as well as in the kinematics and dynamics of the Galaxy on the whole. The above reasons prove the importance of the census, systematic study and survey of MoC populations.

2. CENSUS AND CATALOG

To attempt to find solutions for at least some issues regarding the physics and evolution of the MoC system in our Galaxy and their impact on the dynamics and evolution of the Galaxy generally, and to extend the results to MoC systems in other galaxies, we drafted a consolidated and unified composite all-sky catalog of molecular and dust-gas clouds that are observable from the Earth based on recent data. The preliminary results were reported in Hojaev et al. (2013). Electronic data bases and webservices such as VizieR, SIMBAD at CDS, 2MASS (Ks Atlas) and DSS as well as original papers, reports and other publications were used. The general catalog has been divided into 3 sub-catalogs: 1) large and giant MoCs; 2) MoCs with moderate masses and sizes; 3) small MoCs including clumps and cores. All main catalogs and subcatalogs contain the coordinates, sizes, distances, masses and other physical parameters (such as density, temperature, radial velocity, etc.) that are available for the different clouds. In our Galaxy there are about 200 large and giant molecular clouds, more than 2500 smaller cold dark clouds (including clumps and cores this value exceeds approximately 6000 objects) observed in the Solar vicinity and neighborhood up to 11 kpc away.

3. ANALYSIS AND DISCUSSION

Based on the data in the combined catalog, we analysed physical conditions in the MoCs and searched for relations between the physical parameters of the MoCs observed. Due to the space limitations, we restrict ourselves to discussing only a few. In Figure 1, we present a plot of the column density of molecular hydrogen as a function of the cloud virial mass. The linear fit to the data is: $N(H_2) = 0.04 \times Mvir + 1.6$. The interdependence of the concentration (density) of hydrogen molecules and their column density is shown in Figure 2; this relationship can be represented as $n(H_2) = 0.37 \times N(H_2) + 1.2$. The peak radio flux in the 1.2 mm range, it seems, is correlated with the column density of molecular hydrogen and the plot of these parameters is given in Figure 3. The best fit shown corresponds to $F^{peak}_{radio} = 0.148838 \times [n(H_2)]^{0.376271}$ (solid line), while the fit $F^{peak}_{radio} = 0.818343 \times log[n(H_2)]^{-3.26727}$ (dashed line) is also applicable. And, finally, a plot

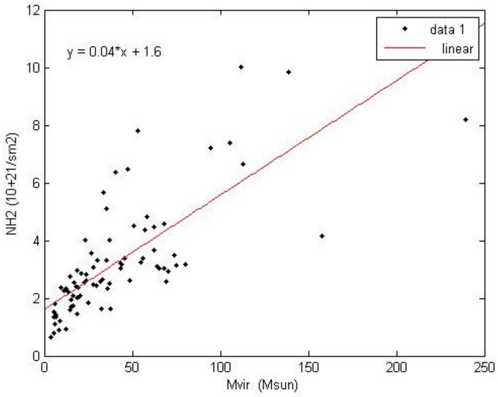

Figure 1. Plot of column density of molecular hydrogen vs the cloud virial mass.

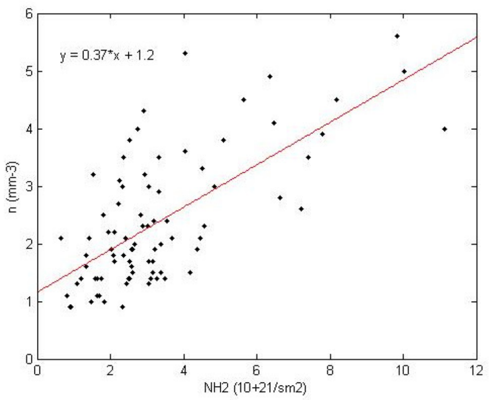

Figure 2. Plot of concentration (density) of hydrogen molecules vs the column density.

of the ^{13}CO column density as a function of the total molecular mass is shown in Figure 4. The relationship can be fitted by $N(^{13}CO) = 0.00213044 \times M^{3.90503}$. Furthermore, a statistical analysis of the cataloged data has been performed, the spatial distribution of MoC was drawn, a dynamic model of the formation and evolution of MoC systems has been proposed and its stability was numerically computed.

4. CONCLUSIONS

In summary, a complex consolidated and unified composite all-sky catalog of molecular and dust-gas clouds observed from the Earth has been drafted. A statistical and correlation analysis has been performed, which revealed some relationships between the physical features of the MoCs. In conclusion, we prepared a complex program for further observations of MoCs using the SUFFA radio telescope in Uzbekistan and other large facilities to cover the gaps in observed data for the physical parameters of MoCs. These results will be used for modelling the dynamics and evolution of the ISM as well as the Galaxy (galaxies) in general, and for physical modelling of the ISM.

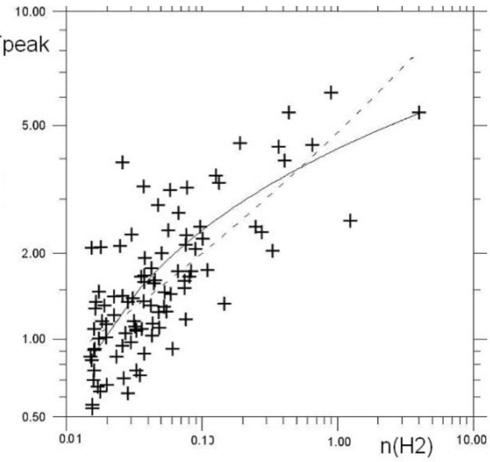

Figure 3. Plot of the peak radio flux at 1.2 mm $[mJy]$ vs column density of molecular hydrogen$[10^4 cm^{-3}]$.

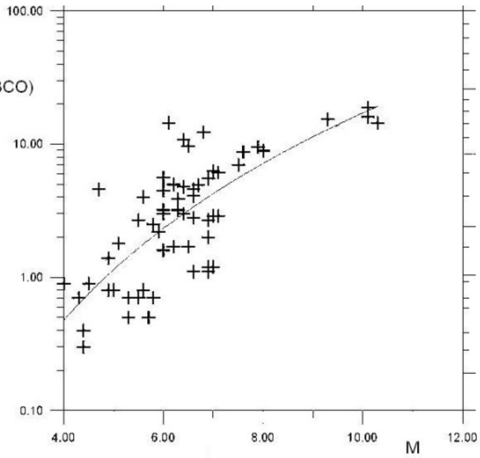

Figure 4. Plot of the carbon monoxide ^{13}CO column density $[10^{16} cm^{-2}]$ vs the total molecular mass $[10^3 M_{\odot}]$.

ACKNOWLEDGMENTS

This research has been partially supported by the Science and Technology Committee of Uzbekistan (grant UzSTC F-2-57) and it has made use of the SIMBAD database, operated at CDS, Strasbourg, France. The publication also makes use of data products from the Two Micron All Sky Survey (2MASS), which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. We also use data from Digitized Sky Survey which were produced at the Space Telescope Science Institute under U.S. Government grant NAG. W-2166. We are thankful to the anonymous referees for useful comments.

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