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Molecular gas properties in early-type galaxies

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1. Summary

We present detailed study of the physical properties of the molecular gas in a sample of 18 gas-rich early-type galaxies -ETGs- from the ATLAS^{3D} sample. Our goal is to better understand the star formation processes occurring in those galaxies, starting in this work by determining the properties of their molecular star-forming gas. Such study has never been performed before for ETGs and open a new window for exploring the star formation processes in the Universe. We use here the ^{12}CO(1-0, 2-1), ^{13}CO(1-0, 2-1), HCN(1-0) and HCO$^+$(1-0) transitions already obtained (Krips *et al.* 2010 and Crocker et al. 2012 and new detections of the ^{12}CO(3-2) line that we present too (see Bayet *et al.* 2012, re-submitted). From this dataset, we derive the average H_2 kinetic temperature, H_2 volume density and column density of the emitting gas using a non-Local Thermodynamical Equilibrium theoretical approach. For most of the gas-rich ETGs included in our sample, the CO transitions can be reproduced by gas kinetic temperatures between 10-20 K, densities of 10^{3-4} cm^{-3} and CO column densities of 10^{18-20} cm^{-2}. Since the CO lines trace different physical conditions than those required to emit the HCN and HCO$^+$ lines, they are treated separately. The physical parameters corresponding to the HCN and HCO$^+$ gas component suffer from large uncertainties and have to be considered as indicative only. In this study, for the first time, we also compare the predicted CO spectral line energy distributions of our gas-rich ETGs and their gas properties with those of a sample of nearby well-studied disc galaxies. The gas excitation conditions in 12/18 early-type galaxies appear analogous to those in the center fo Milky Way, hence the star formation activity driving these conditions may be of a similar strength and nature. The conclusions drawn have to be nevertheless considered carefully since they are based only on a limited number of observations. We show from our models that the ^{12}CO(6-5) line emission is particularly useful for improving these results.

References

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