R13a A statistical study of molecular emission in the starburst galaxy NGC 253 using principal component analysis (PCA)

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Spectral line surveys in the mm-/sub-mm wavelength are useful in obtaining the physical conditions of molecular clouds. Because these physical conditions are likely associated with star formation activities, it is meaningful to conduct line surveys in various environments. In this work, we will discuss how molecular cloud properties are related to activities in the local starburst galaxy NGC 253. The data we use are from the ALCHEMI survey, one of the Cycle 5 ALMA Large Programs. It is a wide-frequency (85-375 GHz) line survey targeting the central molecular zone (CMZ) of NGC 253. We use principal component analysis (PCA) to investigate the relationship between velocity-integrated intensity images of various molecular line transitions and radio recombination lines ($\sim$ 150 transitions in total). This is likely the largest that have been applied to PCA using molecular lines. Our results show that all the transitions have positive values in the first principal component (PC1), suggesting overall gas content. On the other hand, PC2 shows the anti-correlation between the low-J shock tracers (e.g., methanol) and star formation tracers (e.g., radio recombination lines). This relation may imply that shock or turbulence hinders star formation. At the same time, this anti-correlation may also be due to collision-induced star formation with a time delay after cloud collisions.