

Line Ratio Diagnostics along the Disc of Two Edge-on Lenticular Galaxies, NGC 4710 and NGC 5866

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We present interferometric observations of a multitude of CO lines and dense gas tracers in two nearby edge-on lenticular galaxies, NGC 4710 and NGC 5866. $^{12}\text{CO}(1-0)$, $^{12}\text{CO}(2-1)$, $^{13}\text{CO}(1-0)$, $^{13}\text{CO}(2-1)$, $\text{HCN}(1-0)$, $\text{HCO}^+(1-0)$, $\text{HNC}(1-0)$ and $\text{HNCO}(4-3)$ were detected in both galaxies. The detections of $\text{HNC}(1-0)$ and $\text{HNCO}(4-3)$ are presented here for the first time in these early-types. Our observations reveal that the CO gas is much more extended compared with the dense gas tracers, which are generally centrally concentrated except $\text{HCN}(1-0)$ which was also detected in the outskirts of NGC 5866. The unique X-shape (two-component velocity distributions indicating a nuclear disc and inner ring) position-velocity diagrams (PVD) of these barred edge-on galaxies allow us to study integrated line intensity ratios as a function of projected radius along the velocity components. We study the gas physical conditions of a two-component molecular ISM, i.e. one traced by CO and one traced by HCN, HCO^+ , HNC and HNCO, in each velocity component separately, by performing line ratio diagnostics in three complementary ways. In the nuclear disc, the CO gas is gravitationally unstable, optically thinner, hotter and the dense gas fraction is higher, while in the inner ring the gas is more settled, optically thick, colder and the dense gas fraction is lower. We also compare the line ratios to that obtained in the nucleus of other lenticular, spiral, seyfert, starburst and peculiar galaxies, as well as those obtained in the GMCs of some other spirals/starbursts. We found that the gas in the nuclear discs of NGC 4710 and NGC 5866 has line ratios similar to that in the center of starburst galaxies, while the gas in the inner rings show some differences. We finally perform non-LTE radiative transfer modeling of the two-component ISM using a multitude of tracers. The model results, which agree with the empirical results, indicate that there is a factor of 2 difference in the density of the gas traced by CO and the one traced by high density tracers in the nuclear disc but the average kinetic temperatures are similar, while the gas in the inner ring is relatively colder and less dense compared to the gas in the nuclear disc.