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# **Connecting CO-to-H<sub>2</sub> Conversion Factors to Molecular Gas Properties in Nearby Barred Galaxy Centers**

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The CO-to-H<sub>2</sub> conversion factor ( $\alpha_{\text{CO}}$ ) is central to measuring the amount and properties of molecular gas. However,  $\alpha_{\text{CO}}$  is known to vary with environmental conditions, and previous kpc-scale studies have revealed 5-10 times lower  $\alpha_{\text{CO}}$  in the centers of some nearby barred galaxies, including NGC 3351, NGC 3627 and NGC 4321. We present ALMA Band 3, 6, and 7 observations toward the inner  $\sim 2$  kpc of these galaxies tracing  $^{12}\text{CO}$ ,  $^{13}\text{CO}$ , and  $\text{C}^{18}\text{O}$  lines on  $\sim 100$  pc scales. Using multi-line radiative transfer modeling and Bayesian likelihood analysis, we constrain molecular gas properties and  $\alpha_{\text{CO}}$  on a pixel-by-pixel basis. A 2-10 times lower-than-Galactic  $\alpha_{\text{CO}}$  value is found in most regions, and there is a strong correlation between  $\alpha_{\text{CO}}$  and low- $J$   $^{12}\text{CO}$  optical depths which dominate the  $\alpha_{\text{CO}}$  variation in all three centers. The galaxy nuclei within the inner  $\sim 300$  pc tend to show enhanced temperature, density, and velocity dispersion that may drive distinct  $\alpha_{\text{CO}}$  in those regions. We find that the observed  $\text{CO}/^{13}\text{CO}$  (2-1) line ratio generally reflects changes in CO optical depth, and thus it may be a useful observational tracer for  $\alpha_{\text{CO}}$  variation in galaxy centers. We also test current simulation-based  $\alpha_{\text{CO}}$  prescriptions on these centers and find rough agreement in most regions, while clear discrepancy is seen in the inflows and nuclei with strong dynamical features.