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Jet-Driven Inflow and Physical conditions of Molecular gas in NGC 1068 from CO(1-0) and CO(2-1) observations

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We present a detailed analysis of molecular gas in jet-interacting regions of NGC 1068 using ALMA archival data of CO(1-0) and CO(2-1) transitions. We identified a distinct feature where CO(1-0) shows redshifted absorption while CO(2-1) exhibits emission at the same location and velocity, observed consistently across several regions along the jet. Spectral profiles of CO(2-1) reveal redshifted secondary emission components, while CO(1-0) shows blended inverse P-Cygni-like absorption, particularly on the northeast (approaching) side of the jet. These redshifted features are interpreted as inflowing molecular gas, with the CO(2-1)-only component at $\sim 1230 \text{ km s}^{-1}$ likely tracing denser or shock-heated gas and CO(1-0) is likely tracing low density clouds or diffuse gas. Our results provide strong evidence for jet-driven inflow, highlighting the dual role of AGN jets in both removing and funnelling gas toward the nucleus. Excitation temperatures and optical depths were derived from a combination of emission and absorption line, revealing the physical condition of the gas.

Excitation temperatures were derived assuming local thermodynamic equilibrium (LTE), yielding values ranging from 69 K to 83 K across the studied regions. Using optical depth measurements we computed CO column densities of $(2.61\text{-}4.38) \times 10^{14} \text{ cm}^{-2}$, corresponding to H_2 column density of $(3.26\text{-}5.47) \times 10^{14} \text{ cm}^{-2}$. Molecular gas masses were estimated from the integrated CO(1-0) fluxes, yielding values between 1.85×10^{27} and $2.11 \times 10^{27} M_{\odot}$.

Section

Galaxy/Extragalactic

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