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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 $\mathrm{km\,s^{-1}}$ 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 (2.61-4.38) $\times\ 10^{14}\ \mathrm{cm^{-2}}$, corresponding to H_2 column density of (3.26-5.47) $\times\ 10^{14}\ \mathrm{cm^{-2}}$. Molecular gas masses were estimated from the integrated CO(1-0) fluxes, yielding values between 1.85×10^{27} and $2.11 \times 10^{7}\ \mathrm{M_\odot}$.

Section

Galaxy/Extragalactic

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