R35a Molecular Gas in the Nuclei of Spiral Galaxies

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We report the characteristics of molecular gas in the central regions of spiral galaxies on the basis of our CO($J = 1 - 0$) imaging survey of 20 nearby spiral galaxies using the NRO and OVRO millimeter arrays. We have found in the majority of galaxies a strong concentration of CO emission toward the galactic center. The radial scale lengths of these concentrations, $\lesssim 0.5$ kpc, are much smaller than those of disk molecular gas. Within a radius of 0.5 kpc, the estimated gas and dynamical masses range over $10^{8-9} M_\odot$ and $10^{9-10} M_\odot$, respectively. Statistically significant difference is found for the first time in the degree of nuclear gas concentration between barred and unbarred galaxies; molecular gas is more strongly concentrated to the central kiloparsec in barred systems. This finding strongly supports the theoretical predictions that bars can funnel gas to the nucleus. It also suggests that time-averaged gas inflow rate has exceeded the mean star formation rate in the nuclear regions, and that if bars are to be destroyed by these gas concentrations the destruction time scale is longer than the gas consumption time.

Despite the large concentrations of molecular gas toward the nuclei, no clear correlation is found between gas mass and the type of nuclear spectrum (HII, LINER, or Seyfert), suggesting that the amount of gas at this scale does not determine the nature of the nuclear activity. There is, however, a correlation for galaxies with larger gas-to-dynamical mass ratios to have HII nuclear spectra, while galaxies with smaller ratios show Seyfert or LINER spectra. This trend may well be related to the gravitational stability of the nuclear gas disk, which is generally lower for larger gas mass fractions. It is therefore possible that all galaxies have active nuclei, but that the AGN are overwhelmed by the surrounding star formation when the nuclear molecular gas disk is massive and unstable.