The Chemical Anatomy of Nuclei of Nearby Barred Spiral Galaxies

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We present images of the millimeter lines of eight molecules—C_2H, $C^{34}S$, N_2H^+, CH_3OH, HNCO, HNC, HC_3N, and SO—in the nuclei of the nearby barred spiral galaxies, IC 342 and Maffei 2, made with the OVRO and BIMA arrays. These maps are compared to obtain a picture of changes in chemistry on sizescales of individual giant molecular clouds (GMCs) within a nucleus and between nuclei of similar morphological type. Emission from all species except SO are detected in both galaxies. Marked differences in morphology between the observed species are seen in both galaxies. A principal component analysis (PCA) is performed to quantify differences among the images. In IC 342, the PCA reveals that while all molecules are zeroth order correlated, that is, trace dense GMCs, there are three distinct groups of molecules distinguished by the location of their emission within the nucleus. N_2H^+ and HNC are widespread and bright, tracing all of the GMCs. C_2H and $C^{34}S$, tracers of photo-dissociation region chemistry, originate exclusively from the central $\sim 5''$ ring illuminated by the 60 Myr, massive central cluster. CH_3OH (and HNCO), a typical tracer of grain processing, correlates well with the expected locations of bar-induced orbital shocks. In Maffei 2, the PCA demonstrates that its chemistry is quite similar to IC 342, with the molecules tending to couple together in the same groups and with the same structural components of the nucleus. C_2H dominates from the central starburst region, but is significantly more extended than IC 342 because its star formation is more extended. The correlation between HNCO and CH_3OH in Maffei 2 is even strongly than in IC 342, being entirely dominated by the bar ends and orbit intersections. This provides strong evidence that HNCO is formed by the same processes as CH_3OH.

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