

# Chemical Differentiation in Nearby Starburst Spirals

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## Abstract.

In this poster, we analyze high spatial resolution ( $\sim 5'' - 10''$ ) images of the millimeter lines of a collection of molecules, in the nuclei of the nearby starburst spiral galaxies, IC 342 and Maffei II. The data, including transitions of  $C_2H$ ,  $C^{34}S$ ,  $N_2H^+$ ,  $CH_3OH$ ,  $HNCO$ ,  $HNC$ ,  $HC_3N$ , and  $SO$ , were obtained with the OVRO and BIMA millimeter interferometers. These maps are used to trace changes in chemistry on size scales of individual giant molecular clouds (GMCs) within each nucleus. Marked differences in morphology between the observed species are seen in both galaxies. A principal component analysis (PCA) is presented to identify species with coupled chemistries. We focus on the morphology of three distinct chemical groups, (1) dense, quiescent gas tracers, (2) photo-dissociation region (PDR) tracers, and (3) shock/grain processing species. The PCA analysis demonstrates that, aside from minor idiosyncrasies, the chemistry is quite similar in both IC 342 and Maffei II. The observed molecules couple together in the same grouping and associate with the same structural components of the nucleus.  $N_2H^+$  and  $HNC$  are found to be surprisingly widespread and bright in both galaxies. An individual nitrogen-rich GMC is discovered for the first time in an external galaxy. The implications of the high  $N_2H^+$  abundances for elevated cosmic-ray ionization and time dependent chemistry are discussed. In IC 342 tracers of PDRs originate exclusively from the central  $\sim 5''$  ring illuminated by the massive, central cluster. PDRs are more extensive in Maffei II, consistent with slightly older, more extended star formation.  $CH_3OH$  (and  $HNCO$ ), a typical tracers of grain processing, correlates well with the expected locations of bar-induced orbital shocks in both galaxies. The correlation between  $HNCO$  and  $CH_3OH$  in Maffei II is even strongly than in IC 342, being entirely dominated by the bar ends and orbit intersections. This provides strong evidence that  $HNCO$  forms by the same processes as  $CH_3OH$ . In IC 342, we find a GMC with chemical properties very similar to Sgr B2. No such core is obvious in Maffei II. Implications from, and for the Galactic Center are discussed.

**Keywords.** astrochemistry — galaxies: starburst — galaxies: ISM — radio lines: galaxies

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