ATOMIC ISM IN THE NUCLEAR STARBURST REGIONS OF M82 & NGC 253

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1. M82

M82 (NGC 3034) is a nearby (D = 3.3 Mpc) "prototypical" starburst galaxy which emits most of its luminosity in the infrared ($L_{IR} = 3\times10^{10}\ L_{\odot}$, see Rieke et al. 1980). M82 is also a strong radio source 3C 231, with numerous compact knots which are thought to be young SNR's (Kronberg *et al.*, 1981; Muxlow *et al.*, 1994). Its strong 1.4 GHz radio continuum is extended over the entire 500 pc nuclear starburst region, and the HI absorption is easily mapped at 2″ (30 pc) resolution using the VLA. The resulting velocity integrated optical depth ($\tau\Delta V$) map can be converted to HI column density map if HI spin temperature (T_{sp}) is known.

The comparison of the velocity integrated HI optical depth map with the CO (1–0) emission map at similar resolution by Shen & Lo (1995) reveals a good correspondence between the HI optical depth and CO emission and suggests that the atomic and molecular gas distribution is co-spatial in the nuclear starburst region. This is expected if the atomic medium represents the outer skin of the dense molecular clumps that are bombarded by the strong radiation field of the young massive stars. The atomic fraction of the gas is ∼10%.

Y. Sofue (ed.), The Central Regions of the Galaxy and Galaxies, 131-132.

The HI absorption column is significantly lower than CO on the west side, and CO emission extends much further out than HI. While the nuclear gas complex has been traditionally described as a ring or a torus, the observed HI absorption and CO emission is better explained if the dense gas in the nuclear region of M82 forms a tightly wound pair of spiral arms.

2. NGC 253

NGC 253 is another nearby ($D = 3.3$ Mpc) "prototypical" starburst galaxy like M82 ($L_{IR} = 3 \times 10^{10}\ L_{\odot}$, see Rieke et al. 1980). The HI absorption is mapped at 3″ (45 pc) resolution using the VLA against the strong nuclear continuum emission (Ulvestad & Antonucci 1994, 1997). Unlike M82, both the radio continuum and HI absorbing column are highly centrally concentrated. The HI absorption column only vaguely resembles the CO emission (Canzian et al. 1988, Yun et al., in prep.), which is thought to arise in a molecular bar. It is remarkable that no HI absorption is seen in much of the outer "bar" even though radio continuum extends as far as the CO emission. While many aspects of nuclear starburst in NGC 253 are strikingly similar to those of M82, the gas properties are very different, and the explanation most likely lies in its much younger (and perhaps distinct) history of starburst in NGC 253.

3. Summary

The atomic gas generally follows the molecular gas distribution in the regions where star formation is currently active, and this suggests the coexistence of two gas phases, and the atomic gas fraction is about 10%. The absence of HI absorption on the west side of M82 suggests that the nuclear gas complex has a radial structure like a tightly wound arms rather than a complete torus. Both the continuum and HI absorption regions are much more compact in NGC 253, and this may be explained by the relative young age of its starburst. The observed significant differences between HI absorption and CO emission is also consistent with this conclusion.

References

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