Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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High-resolution radio data of molecular gas in dwarf starburst galaxies

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1. Introduction and observations

Star-formation in dwarf starburst galaxies can be quite intense for their sizes, especially in the very young ones characterized by Wolf-Rayet emission features. Since stars form out of molecular gas (H_2), it is important to investigate in detail, where the molecular gas is relative to the star formation in such young starbursts. The molecular gas may also indicate what might have triggered the starburst. The ISM in dwarfs can be quite warm, is the molecular gas also warm? In an attempt to investigate the properties of molecular gas in WR galaxies we have obtained high resolution images of the $J = 2$–1 transitions of CO for two dwarf starbursts, NGC 5253 and He2-10. Both galaxies are nearby dwarf starbursts with WR emission features (*e.g.*, Conti 1991). NGC 5253 may be one of the youngest starbursts known (*e.g.*, Rieke, Lebofsky & Walker 1988).

The observations of the CO(2–1) line at 230.538 GHz for both galaxies were made using the Owens Valley Millimeter Array (*OVRO*) between May 1996 and February 1998. The array consists of six 10.4 meter antennas. Each observation consisted of three closely spaced pointings ($< 8''$ separation) and were mosaiced in MIRIAD. The mosaicing leads to a field of view (limited by *OVRO*'s primary beam) of $\sim 40''$. The data was smoothed to increase the S/N, giving a $4'' \times 8''$ beam for NGC 5253, and a $4''$ beam for He2-10.

2. Results

CO(2–1) is quite weak relative to the strength of the starburst as indicated by ionizing flux. These is especially true for NGC 5253. The peak intensity of CO(2–1) is only $8 \pm 1\,\mathrm{K\,km\,s^{-1}}$ ($T_p \simeq 0.3\,\mathrm{K}$) for NGC 5253 (Figure 1a), and $40 \pm 8\,\mathrm{K\,km\,s^{-1}}$ ($T_p \simeq 1.0\,\mathrm{K}$) in He2-10 (Figure 1b). Weak CO emission is a common feature in low metallicity galaxies like these. As is seen in CO(1–0), (Turner, Beck & Hurt 1997 [NGC 5253]; Kobulnicky 1995 [He2-10]), CO(2–1) traces out the prominent optical dust lanes seen in both galaxies. But CO(2–1) appear to fall off more quickly as one moves away from the nucleus. For He2-10, the $\sim 20''$ tidal tail seen in CO(1–0) (Kobulnicky *et al.* 1995) is not prominent. CO(2–1) are confined to a couple of spots along the tail: *(1)* the dust lane

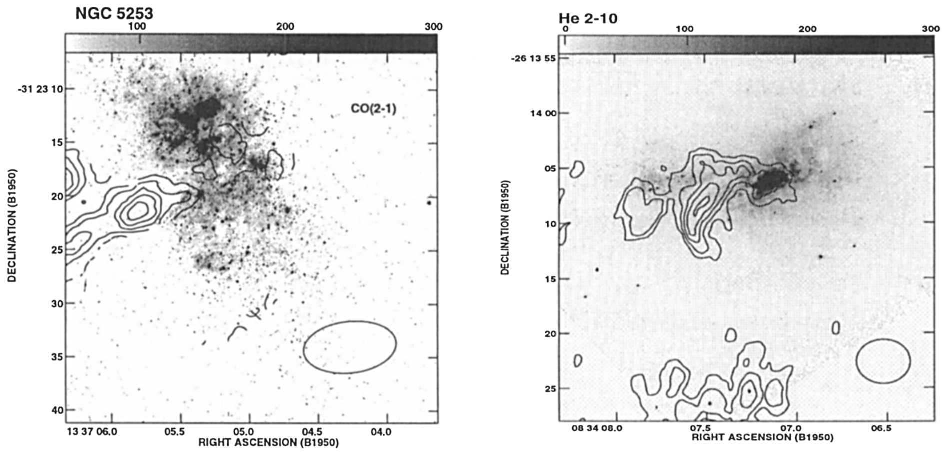

Figure 1. CO(2-1) overlayed on the *HST* F555 images. *Left:* NGC 5253; *right:* He2-10

between the two starburst regions, and *(2)* towards the end of the southern end of the tidal feature.

Calzetti *et al.* (1997) find that the brightest star-forming region in the NE of NGC 5253 is a site of high dust extinction. We *do not* see any CO(2–1) emission from this location! We suggest that in the immediate region of the starburst the interstellar radiation field combined with the low metallicity of the galaxy results in almost complete photo-dissociation of CO, but not necessarily H_2. There definitely is dust and probably H_2 in the core of the galaxy, but it is rendered undetectable in CO. On the higher resolution scales entire molecular clouds may be invisible in CO, implying not only that a standard CO conversion does not apply (*e.g.*, Wilson 1995) in low metallicity systems, but there is a certain cutoff where CO disappears altogether. This is due to the lack of a critical column of CO necessary to be self-shielded.

NGC 5253 has I_{21}/I_{10} integrated intensity line-ratios of 0.7 ± 0.3, while for He2-10 we find $I_{21}/I_{10} = 0.5 \pm 0.2$ (taking into account resolved-out emission). The CO line-ratios are low, which is consistent with warm, subthermal, moderately low density H_2. The low H_2 densities implied by line-ratios and their separation from the current starburst site indicates that the H_2 traced by CO may not (yet?) be actively involved in the starburst.

References

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