Chandra observations of the dwarf starburst and
Wolf-Rayet galaxies NGC 4449 and NGC 5253

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Abstract. We present an analysis of the Chandra observations of two dwarf
starburst, Wolf-Rayet galaxies (NGC 4449 and NGC 5253). We have identified at
least three different classes of objects within the X-ray point source populations,
and we have found the diffuse emission, resulting from the stellar winds and
supernova explosions of massive stars, to have a complex morphology and to
consist of several components. Comparison with the Hα emission suggests the
presence of ~kpc-scale wind-blown bubbles and ruptured superbubbles.

1. Introduction
X-ray observations of edge-on starburst (SB) galaxies (Strickland et al. 2000;
Weaver 2001) present a picture of kpc-scale, bi-polar outflows, resulting from the
activity of massive stars. Such pressure-driven galactic winds transport mass,
newly synthesized heavy elements and energy into the galactic halo or on into the
IGM. In dwarf SBs, such outflows can have a profound effect on the morphology
and kinematics of the ISM and the galaxy’s evolution. Chandra-AcIS-s3 obser-
vations of the two similar dwarf SB galaxies, NGC 4449 and NGC 5253, have
identified a number of discrete point sources with spectra of different natures
and at least two components within their diffuse emission.

2. Results
Within the D25 ellipse, 24 sources were detected for NGC 4449 and 17 for
NGC 5253 in the 0.3–8.0 keV energy band. The log N vs. log Lx plot of Fig-
ure 1 shows the range of their luminosities. Spectral analysis and hardness ra-
tios for the NGC 4449 sources identify them with at least three different classes
of objects, XRB, SNR and SSS. More high-luminosity sources are detected in
NGC 4449 than in NGC 5253, and one difference between them is that NGC 5253
contains a very young SB at ~3–4 Myr (Schaerer et al. 1997). A single power
law fit to the luminosity functions gives a slope of −0.38 for NGC 4449, com-
parable to the value of −0.45 obtained for M 82 and the Antennae galaxies (Zezas
et al. 2001), while that for NGC 5253 is −0.74.
Figure 1. Left: log $N$ vs. log $L_x$ plots of the resolved point sources within the $D_{25}$ ellipses of the two galaxies. Right: X-ray contours overlaid on an Hα image (kindly supplied by Deidre Hunter) of NGC 4449.

The diffuse emission is seen to be blobby in the central regions of both galaxies around star clusters and extends along their minor axes. Spectral fitting requires two thermal components with the softest one having $kT \approx 0.31$ keV for NGC 4449 and $kT \approx 0.18$ keV for NGC 5253. The hotter components are both less extended and make a smaller contribution to the measured X-ray fluxes. For NGC 4449 $kT \approx 0.82$ keV, and for NGC 5253 it is hotter again with $kT \approx 3.1$ keV. These two different gas components possibly reflect the expected presence of both shock-heated ISM material and shock-heated stellar wind/SN ejecta from the massive stars.

The morphologies and extent of both the Hα and diffuse X-ray emission are similar as shown in Figure 1. Surface brightness profile slices taken through both these emissions (Summers et al. 2002) suggests that the X-ray emission fills $\sim kpc$-scale cavities in the Hα emission indicative of wind-blown superbubbles, and to the NW, the X-ray emission seems to extend beyond the Hα emission, possibly representative of the rupturing of a superbubble along the galaxy’s minor axis. Analysis of XMM-Newton data for NGC 6263 is on-going and will hopefully help to clarify these results.

References