Chandra’s X-ray View of Massive Star-forming Regions
Leisa Townsley    Penn State University

The Chandra X-ray Observatory is providing new insight into the structure, extent, and energetics of massive star-forming regions. Combining Chandra data with new visual and IR images gives a unique multiwavelength picture of these famous regions never before seen.

30 Doradus

Chandra/ACIS-I 0.5--0.7 keV, 0.7--1.1 keV, 1.1--2.3 keV; 110 ks. Bright, soft diffuse X-ray emission dominates the field; these are supernova-filled superbubbles (e.g. Chu & Mac Low 1994).

M17, The Omega Nebula

Chandra/ACIS-I 0.5--2 keV, 2--7 keV; Spitzer/IRAC [5.8], ~20'x30' (~9x14 pc), 92 ks (cavity) + 230 ks (NGC 6618). Chandra finds >2000 X-ray point sources (mainly low-mass pre-main sequence stars plus more massive stars) and extensive diffuse emission (kT ~ 0.6 keV or 7 MK). Spitzer traces heated dust in the photoionization fronts. M17 is the closest giant HII region, D=1.6 kpc.

W3 North

W3 Main

IC 1795

W3(OH)

Chandra finds >1300 sources: small embedded clusters in W3(OH), the populous, less-absorbed, older cluster IC 1795, >700 sources in a rich, large cluster around W3 Main, and notably NO CLUSTER IN W3 NORTH! This illustrates the population diversity possible in triggered star formation.

A FIRE-BREATHING DRAGON: the hot plasma generated by O stars winds appears to emanate from a fissure in this edge-on blister HII region and billow into a more open cavity to the east, outlined and sometimes absorbed by heated dust traced by Spitzer.

This dense cluster sits on the western edge of the Carina I GMC. Chandra detects >1600 X-ray point sources in this short observation and serendipitously images bright diffuse emission off-axis that suggests a CAVITY SUPERNova REMNANT.

NGC 3576

MSX 8 micron, SuperCOSMOS H alpha, ACIS-I 0.5--2 keV. NGC 3576 is the second closest giant HII region (D=2.8 kpc) but the main sources of its ionization are unknown. It contains a very young, obscured massive cluster (yellow oval) powering a large-scale outflow and generating a mid-IR bipolar bubble. The large visual loops and prominent soft diffuse X-ray emission (kT ~ 0.6 keV) may trace this outflowing hot gas. Chandra finds deeply embedded, hard X-ray sources not seen at 3.5 microns; these are likely THE CLUSTERS MISSING MASSIVE IONIZING STARS.