

# Chandra and Spitzer observations of young clusters

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**Abstract.** The combination of spatial and spectral resolution allow us to use *Chandra* in the study regions of massive star formation which had been inaccessible even from the ground until the last decade. IRAC and MIPS data from *Spitzer* can be combined with the X-ray data to provide insight into the presence of a disk and the activity of the star. The total package allows us to better understand the evolution of the clusters. We have an ongoing program to study several young star forming clusters including distant clusters between 1-3 kpc which support O stars, RCW 38, NGC 281 and RCW 108 and well as clusters within a kpc including IRAS 20050+2720 and NGC 1579, which is a small cluster centered on the Be star LkH $\alpha$ 101 and is of uncertain distance although the X-ray data help us refine the current distance estimates. Given the space constraints we only discuss RCW 108 below.

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## 1. RCW 108

RCW 108 contains a deeply embedded young cluster lying in a dark cloud to the west of the young open cluster NGC 6193 (excited by two early O stars). The cluster is obscured by  $A_v \sim 20$  and is at a distance of 1.3 kpc and so is more embedded and closer than RCW 38. The exciting source of the IRAS cluster is  $\sim O6-8$ . At 8-20  $\mu\text{m}$ , the Midcourse Space Experiment Galactic Plane Survey data shows a ridge of warm dust passing through the eastern edge of the emission peak and traversing 15 minutes in a north-south ridge parallel but west of the optical ridge. Our SEST mm continuum observations show this dust ridge as well. The far infrared luminosity suggests that there is more than one significant heating source, i.e., OB stars and/or intermediate mass protostars. The colors and luminosities of the infrared sources imply an associated cluster of low mass T Tauri stars. The extended infrared nebulosity to the east of the main cluster is due to emission and not reflection, suggesting a break-out of radiation in this direction.

We detected about 350 X-ray sources in our 90 ks observation. The morphology is striking. The region is dominated by unabsorbed sources to the east. These are associated with the older cluster NGC 6193. The sources associated with RCW 108-IR seems to sit in the middle of a void. This is indicative of a dense cloud of neutral gas. Several specific sites of star formation are found within that cloud complex. These align with some, but not all, the 8  $\mu\text{m}$  peaks in the MSX data. There are several sites within the warm dust cloud containing 1-10 stars. The extant *Spitzer* data are from a very shallow early release observation and parallel the X-ray finding of several specific sites of star formation. The overall trigger appears to be compressive with indications of involvements by both winds and photoionization. However, the direction of the star formation seems to random walk from cluster to cluster, often changing direction.