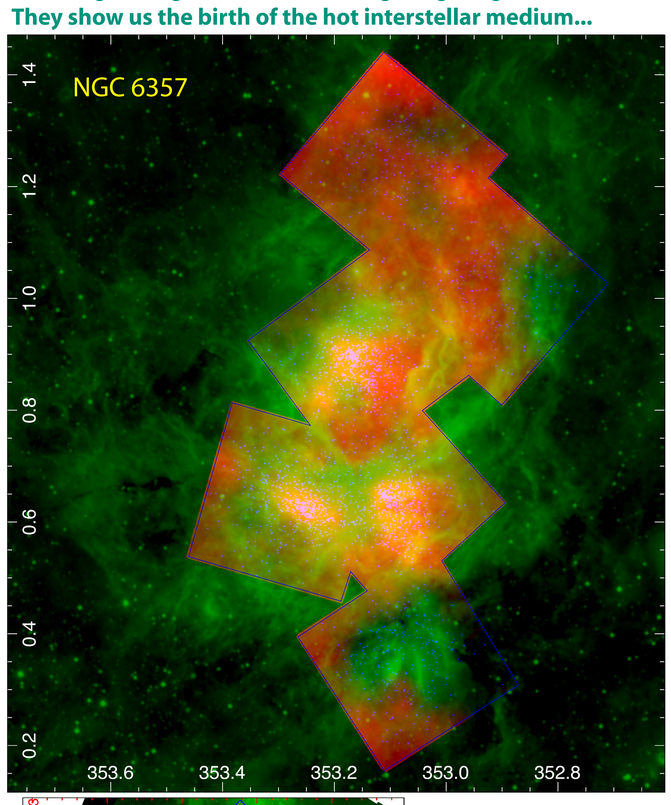
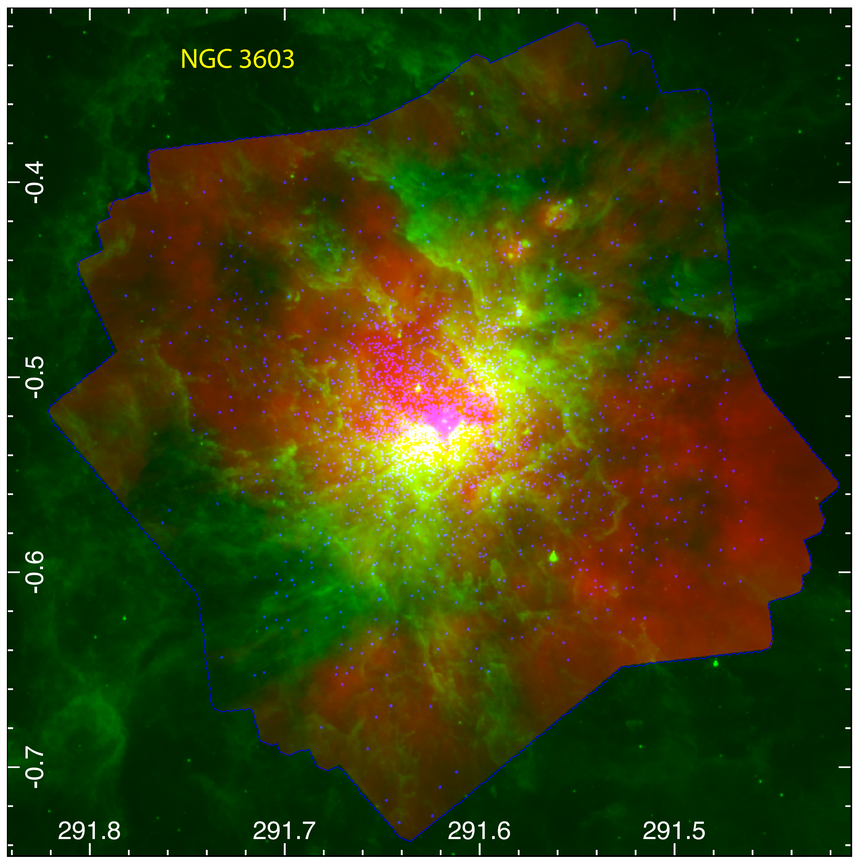
The Birth of the Hot Interstellar Medium: *Diffuse X-ray Emission in Massive Star-Forming Regions*

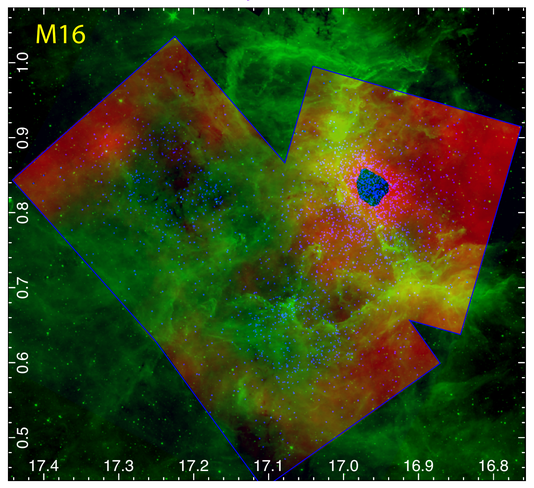
Leisa Townsley & Patrick Broos (Penn State University)

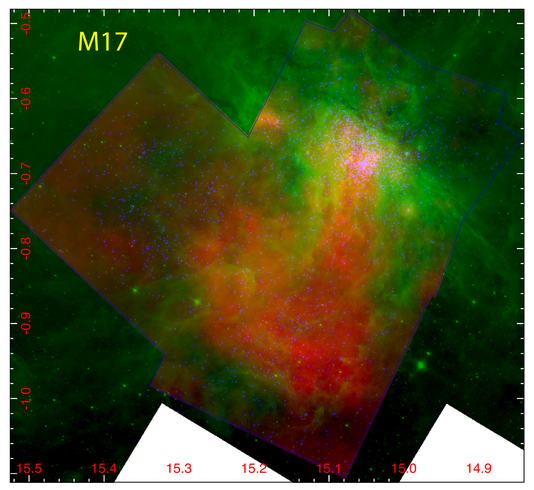
Chandra is providing remarkable new views of massive star-forming regions, revealing the effects of massive star feedback on natal molecular filaments and clouds. These complexes are suffused by parsec-scale diffuse X-ray emission outlined (and sometimes confined) by colder structures seen in long-wavelength images; these are the long-sought signatures of multi-million-degree plasmas created by fast O-star winds.

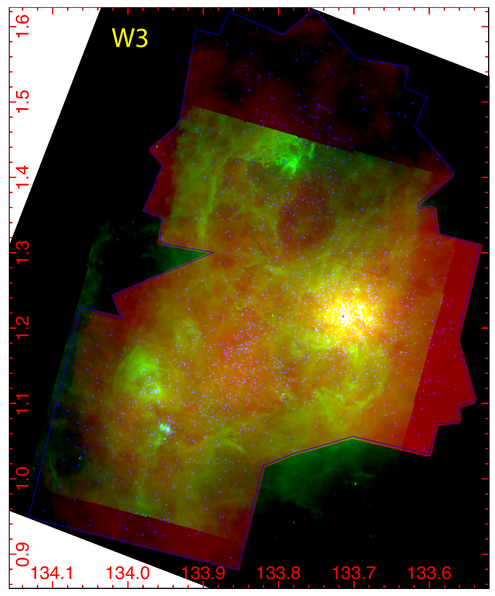
They show us the birth of the hot interstellar medium...

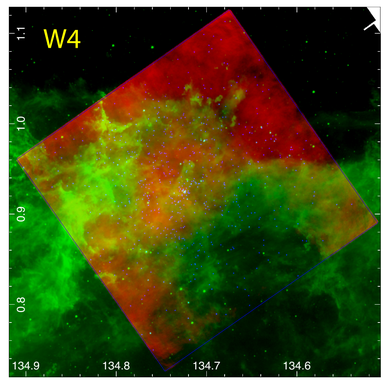


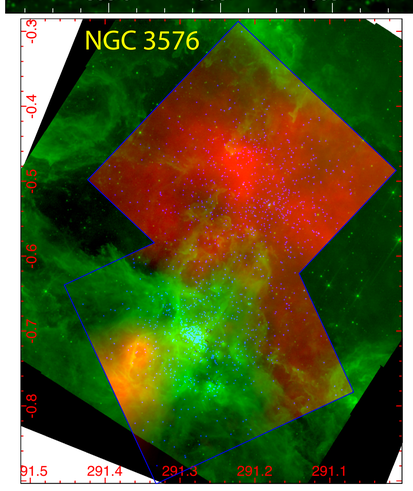


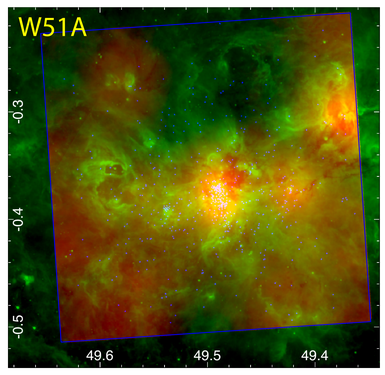


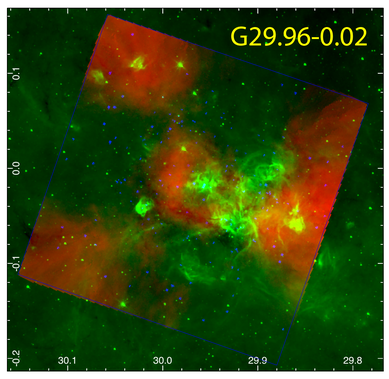




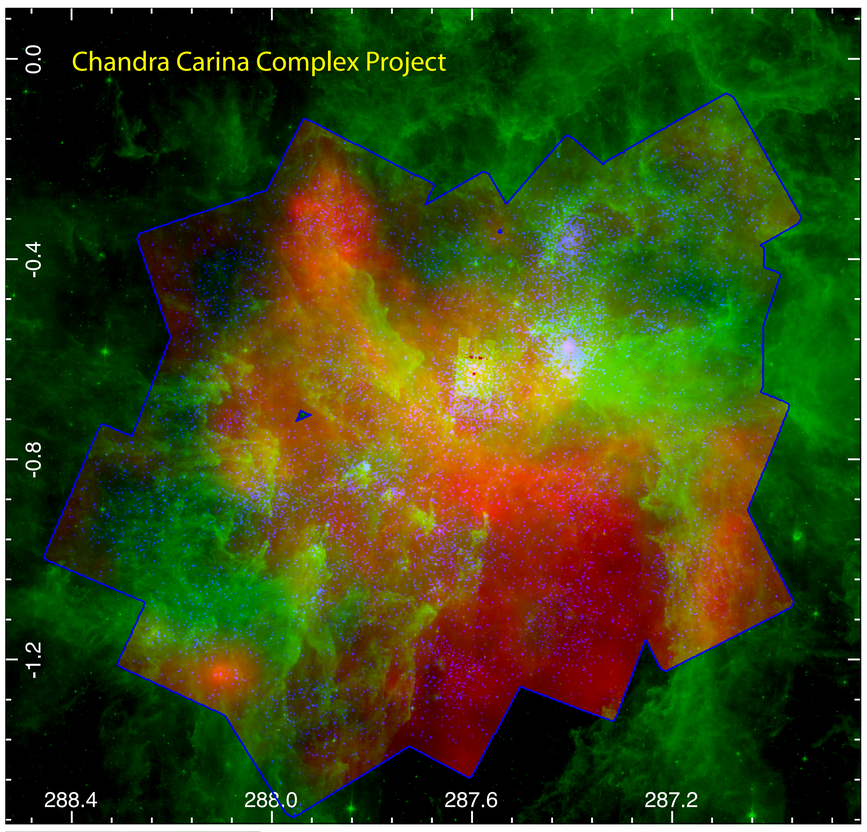




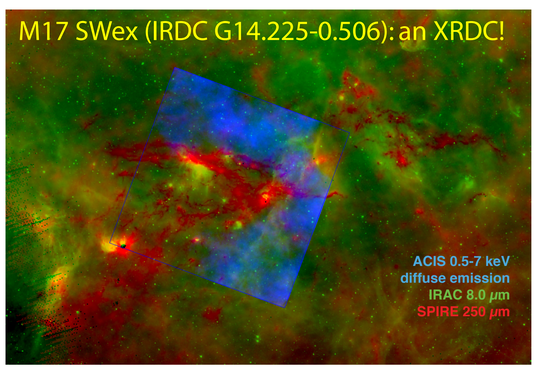


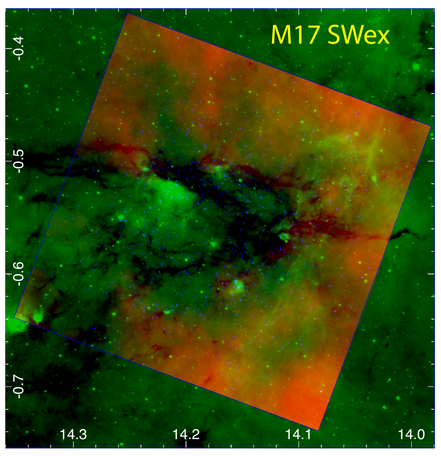


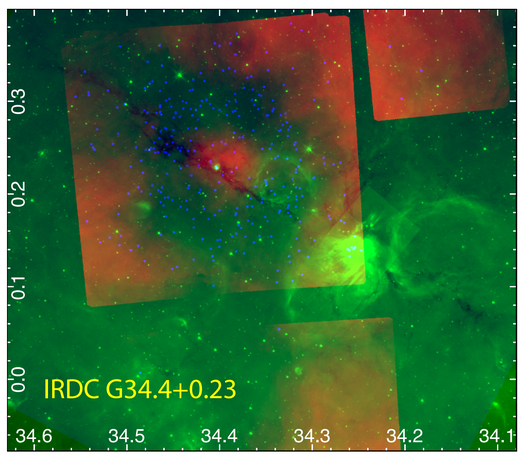
All images in Galactic coordinates; they show **diffuse X-ray emission from Chandra/ACIS-I**, **mid-IR data (usually Spitzer/IRAC 8um)**, and **modeled ACIS point sources** unless otherwise noted.
X-ray point sources were excised to reveal the diffuse X-ray emission (via adaptive-kernel smoothing of the ``swiss-cheesed'' data); they were replaced with Gaussians scaled appropriately to reflect the actual X-ray source photometry. This depiction suppresses the strongly-varying Chandra PSF to offer a more natural--albeit artificial--view of the X-ray sky.



InfraRed Dark Clouds







IRDCs are famous sites of ongoing star formation. X-ray studies of IRDCs are just beginning.

M17 SWex sports a very large number of X-ray-emitting young stars (Povich15) but is largely X-ray-dark in diffuse emission, strongly shadowing background emission but showing no spectral evidence for generating its own hot plasma. This may be because it is underpopulated with massive stars (Povich15).

In contrast, G34.4 may show early signs of massive star feedback (central red spot around EGO) but it is not spectrally distinct -- could be unresolved young stars. A longer observation is needed -- this would resolve out more young stars and boost the diffuse signal, if it is present.

Chandra point sources are catalogued in Broos11, Townsley14. Diffuse X-ray emission studies include Townsley03, Townsley11b,c, Townsley14.

Conclusions

Massive star feedback is manifested as soft diffuse X-ray emission (0.2--0.8 keV), tracing multi-million-degree plasmas threading the complex ISM in massive star-forming regions.

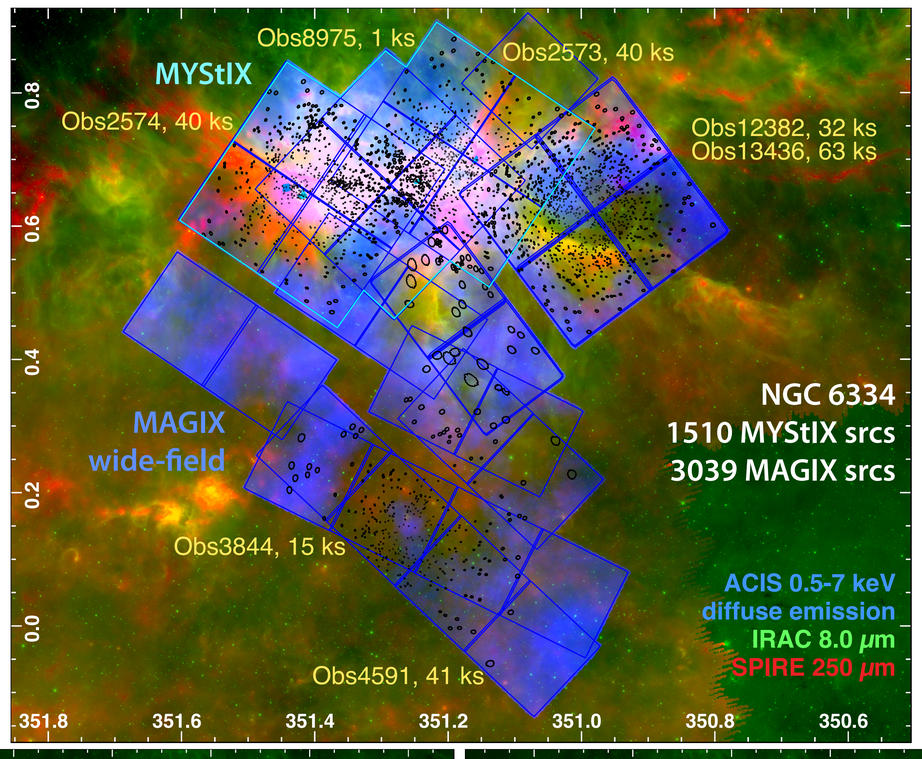
These plasmas are ubiquitous, detectable with modest Chandra exposures even at large Galactic distances, once X-ray point sources are carefully removed.

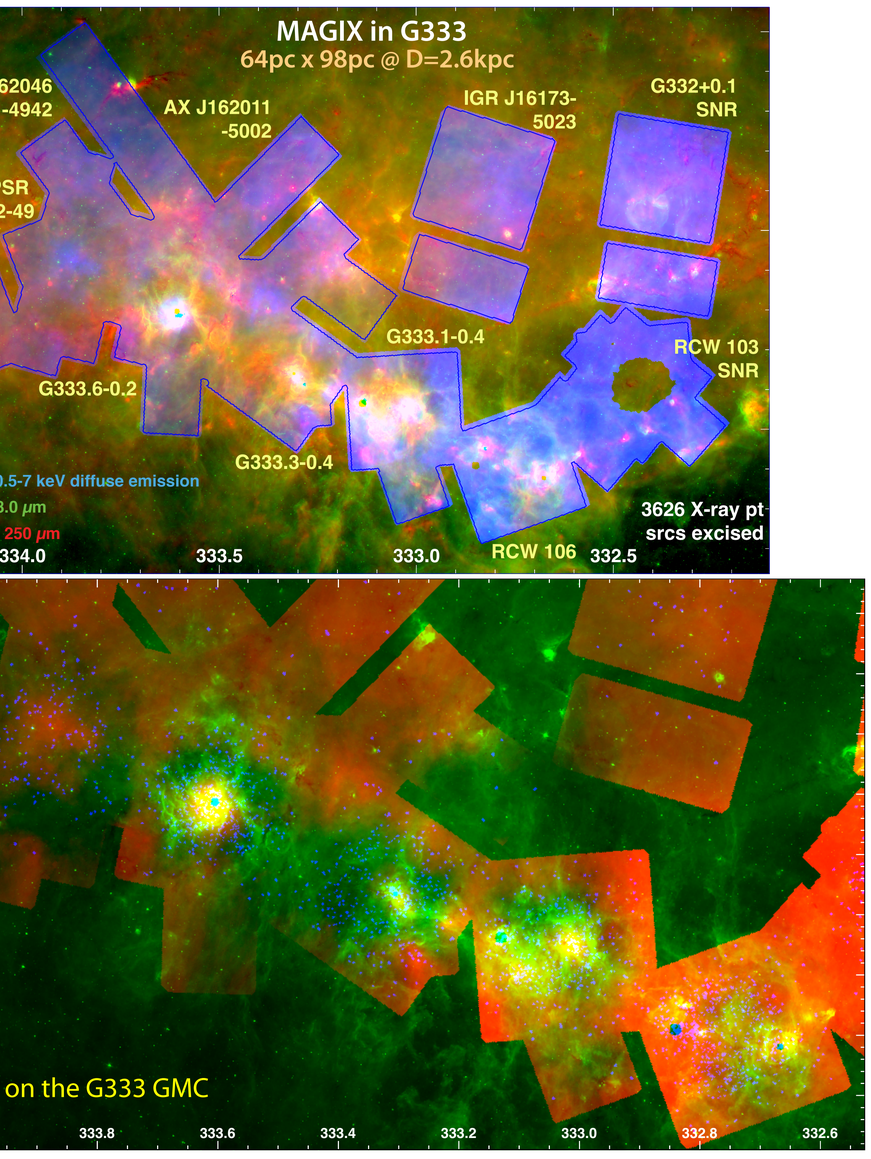
Even very young giant HII regions are fissured and permeable, allowing the escape of hot gas.

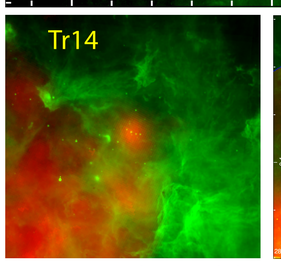
The typical ISM of these regions resembles beer foam, with complex honeycombed walls and cavities where these hot plasmas interface with cold dust and gas and struggle to escape their confinement.

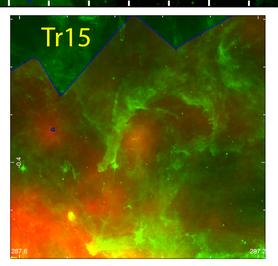
Dreams for the future: **M**assive Star-Forming Regions **A**cross the **G**alaxy in **I**nfrared and **X**-rays (**MAGIX**)

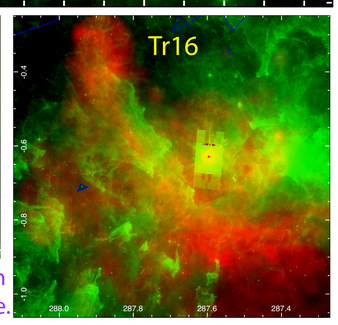
We have enhanced our ACIS Extract analysis tools (Broos10) to accommodate far off-axis data, which are often useful for exploring large-scale diffuse X-ray structures. With this new capability and the extensive Chandra archive, we can explore large star-forming complexes spanning degrees across the sky, including neighboring supernova remnants, X-ray binaries, pulsars, etc. in their full Galactic Plane context.
We hope someday to secure funding to pursue this effort on 20+ of the Milky Way's most important massive star-forming sites, the engines of Galactic evolution.











Carina is a ``cluster of clusters''; diffuse X-ray emission from the most famous of those clusters is shown here.