FAST SHELLS AND X-RAY EMISSION IN 30 DORADUS: SNRS AND SUPERBUBBLES

YOU-HUA CHU
Astronomy Department, University of Illinois
1002 W. Green Street
Urbana, IL 61801
USA

ROBERT C. KENNICUTT, JR
Steward Observatory, University of Arizona
Tucson, AZ 85721
USA

ABSTRACT. We have mapped the kinematics of the ionized gas in 30 Dor, and find numerous examples of fast expanding shells. There is good correlation between the high-velocity material and the bright diffuse X-ray emission in 30 Dor. The fast shells are probably supernova remnants, stellar wind-blown bubbles, or combinations of both.

1. Introduction

The 30 Doradus HII region contains an extraordinary concentration of massive stars whose stellar winds and final supernova ejecta interact violently with the interstellar material. The interaction is evidenced directly in the kinematics of the HII region and indirectly in the X-ray emission from 30 Dor. Complex motions, such as supersonic "turbulent" velocity dispersion (Smith and Weedman 1972) and isolated fast-moving material with velocity as high as 300 km/s (Meaburn 1984, 1988), have been observed. The Einstein IPC also shows that 30 Dor is a bright diffuse X-ray emitter with a luminosity of the order of 10^{37} erg/s in 0.2-3.5 keV (Chu and Mac Low 1990); Walborn 1990; Wang and Helfand 1990).

2. Mapping the Kinematics of 30 Doradus

To better understand the influence of stellar winds and SNRs in the interstellar gas and the physical nature of the X-ray emission in 30 Dor, we mapped the kinematic structure of the HII region, using the échelle spectrograph with Air Schmidt CCD camera on the 4m telescope at Cerro Tololo Interamerican Observatory. Each observation covers ~4' spatially with a resolution of 1-3", and a spectral region including the Hα and [N II]λ6548, 6583 lines with an instrumental FWHM of 21 km/s. The central 9'x9' core was mapped in rectilinear grid, with complete sampling in the E-W direction and 45" spacing N-S. Single cuts through the halo over 25' along N-S and 20' along E-W were also observed.

R. Haynes and D. Milne (eds.), The Magellanic Clouds, 97–98.

3. Fast Shells and X-ray emission in 30 Doradus

Our échelle observations reveal a wide range of kinematic features, ranging in velocity from 20-300 km/s. The most interesting feature is the frequent presence of high velocity material, with velocities $\geq$100 km/s relative to the main component. Some of the high-velocity features can be easily identified as organized expanding shells, while others seem to be isolated clouds or sheets of accelerated material.

The sizes of the fast expanding shells range from a few to 100 pc, with the majority being 15-40 pc, and the expansion velocities range from 130 to 250 km/s; the corresponding dynamic time scales are typically a few times 10^4 yr, except for the largest shell. The expansion is usually asymmetric; often the approaching side has larger expansion velocity, and the receding side, having smaller expansion velocity, is blended in the bright background HII region component.

The smallest shells, a few pc in diameter, do not have any bright X-ray counterparts. A SNR of such small size should still be bright in X-ray; therefore, these smallest shells must be ring nebulae around massive stars, either wind-blown bubbles or stellar ejecta.

The larger shells, 15-100 pc in diameter, correlate extremely well with the diffuse X-ray emission. In some cases the shells have well defined boundary and expansion pattern, while in others there are just high velocity material with similar kinematic properties present within boundaries defined by both optical rings and X-ray contours. The latter cases, which we call "networks", are probably superbubble complexes that contain both stellar wind interactions and SNRs. The SNR shell reported by Meaburn (1988) is contained in one of the networks.

The large fast expanding shells could be wind-blown bubbles, SNRs or the combination of both. It is difficult to determine their nature exactly because of the confusion from the bright HII region background and the high concentration of massive stars. Furthermore, a SNR inside a superbubble may not show the conventional characteristics (Chu and Mac Low 1990). The X-ray data provide a useful constraint on the nature of the shells. The stellar content may provide another constraint; for example, the lack of sufficient stars would require existence of SNRs. However, the stellar content of the shells are mostly unknown.

The authors acknowledge the support of NSF grants AST-8818192 (YHC) and AST-8996123 (RCK). Both authors were visiting astronomers at Cerro Tololo Interamerican Observatory, NOAO, which is operated by AURA, under cooperative agreement with the National Science Foundation.

References

Chu, Y.-H. and Mac Low, M.-M. (1990), *Astrophys J.* in press.
Meaburn, J. (1984), *M.N.R.A.S.* **211**, 521.
Meaburn, J. (1988), *M.N.R.A.S.* **235**, 375.
Smith, M.G. and Weedman, D.W. (1972), *Astrophys. J.* **172**, 307.
Walborn, N.R. (1990), in this volume.
Wang, Q. and Helfand, D. (1990), *Astrophys. J.* in preparation.