X-RAYS FROM SUPERBUBBLES IN THE LARGE MAGELLANIC CLOUD

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

MORDECAI-MARK MAC LOW
Mail Stop 245-3, NASA Ames Research Center
Moffett Field CA 94035
USA

ABSTRACT. We find diffuse X-ray emission not associated with known SNRs in seven LMC HII complexes. All, except 30 Dor, have simple ring morphologies, indicating shell structures. Assuming these are superbubbles, we find the X-ray luminosity expected from their hot interiors to be an order of magnitude lower than the observed value. SNRs close to the center of a superbubble add very little emission, but we calculate that off-center SNRs hitting the ionized shell could explain the observed emission.

1. Introduction

A classical HII region of 10^4 K ionized gas should not emit X-rays. However, a luminous early-type star usually has a strong stellar wind as well as ionizing flux, and the stellar wind may interact with the ambient medium to produce $\sim 10^6$ K X-ray emitting plasma. Furthermore, the most massive stars of an OB association may become supernovae and heat the associated HII region. Therefore, it should not be too surprising that moderately bright X-ray emission has been detected in two HII regions around OB associations in our Galaxy: the Carina nebula (Seward and Chlebowski 1982) and RCW49 (Goldwurm *et al.* 1987). It is suggested that the Carina nebula is heated by stellar winds and RCW49 contains an embedded SNR.

2. X-ray survey of HII regions/OB associations in the LMC

If the X-ray emission from HII regions around OB associations is powered by stellar winds alone, many of the OB associations in the LMC should have been detected by the Einstein IPC. We have inspected the Einstein X-ray contour maps around 75 OB associations in the LMC, and find diffuse X-ray emissions not associated with known SNRs in seven HII complexes encompassing ten OB associations: N44, N51D, N57A, N70, N154, N157 (30 Dor), and N158. The X-ray luminosities range from 7×10^{34} erg/s in N57A to nearly 10^{37} erg/s in 30 Dor. All, except 30 Dor,

R. Haynes and D. Milne (eds.), The Magellanic Clouds, 99–100.

have simple ring morphologies, indicating shell structures that can be described well as "superbubbles".

3. Diffuse X-ray emission mechanisms

The X-ray emission cannot be emitted by the early-type stars, since the X-ray surface brightness does not follow the distribution of stars. It must be emitted by interstellar gas heated to $\sim 10^6$ K, and both stellar winds and supernovae could supply the necessary energy.

Assuming these HII complexes are pressure-driven superbubbles, we can use the bubble structure given by Mac Low and McCray (1988) and calculate the expected X-ray emission from the hot bubble interior. We find the expected X-ray luminosity an order of magnitude lower than the observed value. Adding a SNR in the bubble center does ot increase the X-ray emission much, because the bubble interior is already hot and the density is low. However, adding an off-center SNR may increase the X-ray emission to the observed level when the SNR hits the ionized shell.

4. Modelling

N51D has a radius of 53 pc, an expansion velocity of ~30km/s, and an electron density of 4.5 cm^{-3} in the ionized shell. The observed intrinsic X-ray luminosity of N51D is 3×10^{35} erg/s (Fig 1). Modelling N51D as a superbubble, we expect 3.1×10^{34} erg/s from the hot interior. Adding a SNR in the center will only increase the X-ray emission by about 15%. However, an off-center SNR hitting the ionized shell (Fig 2) may increase the X-ray luminosity to the observed value.

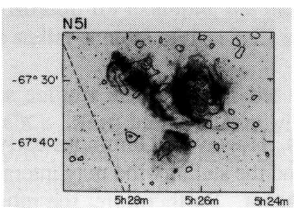

Figure 1 N51D, X-ray contours on Ha image

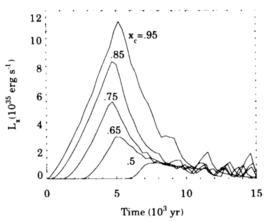

Figure 2 X-ray luminosities of SNRs hitting the dense shell of N51D, for models with initial fractional radii X_c

The authors acknowledge the support of NSF grants AST-8818192 (Y.-H.C.) and AST-8722126 (M.-M.M.L.).

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