Observational Constraints on Superbubble X-ray Energy Budgets

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The hot, X-ray-emitting gas in superbubbles imparts energy and enriched material to the interstellar medium (ISM) and generates the hot ionized medium, the ISM's high-temperature component. The evolution of superbubble energy budgets is not well understood, however, and the processes responsible for enhanced X-ray emission in superbubbles remain a matter of debate. We present Chandra ACIS-S observations of two X-ray-bright superbubbles in the Large Magellanic Cloud (LMC), DEM L50 (N186) and DEM L152 (N44), with an emphasis on disentangling the true superbubble X-ray emission from non-related diffuse emission and determining the spatial origin and spectral variation of the X-ray emission. An examination of the superbubble energy budgets shows that on the order of 50% of the X-ray emission comes from regions associated with supernova remnant (SNR) impacts. We find some evidence of mass-loading due to swept-up clouds and metallicity enrichment, but neither mechanism provides a significant contribution to the X-ray luminosities. We also find that one of the superbubbles, DEM L50, is likely not in collisional ionization equilibrium. We compare our observations to the predictions of the standard Weaver et al. model and to 1-D hydrodynamic simulations including cavity supernova impacts on the shell walls. Our observations show that mass-loading due to thermal evaporation from the shell walls and SNR impacts are the dominant source of enhanced X-ray luminosities in superbubbles. These two processes should affect most superbubbles, and their contribution to the X-ray luminosity must be considered when determining the energy available for transport to the ISM.

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