Title

Chandra ACIS Spectroscopy of N157B: A Young Composite Supernova Remnant in a Superbubble

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Abstract

We present a *Chandra* ACIS observations of N157B, a young supernova remnant (SNR) located in the 30 Doradus star formation region of the Large Magellanic Cloud. This remnant contains the most energetic pulsar known (PSR J053747.39-691020.2; = 4.8 × 10^{38} ergs s^{-1}), which is surrounded by a X-ray-bright nonthermal nebula that likely represents a toroidal pulsar wind terminal shock observed edge-on. Two of the eight pointlike X-ray sources detected in the observation are shown to have near-IR and optical counterparts (within 05 offsets), which are identified as massive stellar systems in the Cloud. We confirm the nonthermal nature of the comet-shaped X-ray emission feature and show that the spectral steepening of this feature away from the pulsar is quantitatively consistent with synchrotron cooling of shocked pulsar wind particles flowing downstream at a bulk velocity close to the speed of light. Around the cometary nebula we unambiguously detect a spatially resolved thermal component, which accounts for about 1/3 of the total 0.5-10 keV flux from the remnant. This thermal component is distributed among various clumps of metal-enriched plasma embedded in the low surface brightness X-ray-emitting diffuse gas. The relative metal enrichment pattern suggests that the mass of the supernova progenitor is 20 *M*. A comparison of the X-ray data with *Hubble Space Telescope* optical images now suggests that the explosion site is close to a dense cloud, against which a reflection shock is launched. The interaction between the reflected material and the nebula has likely produced both its cometary shape and the surrounding thermal emission enhancement. SNR N157B is apparently expanding into the hot low-density interior of the surrounding superbubble formed by the young OB association LH 99, as revealed by *Spitzer* mid-infrared images. This scenario naturally explains the exceptionally large sizes of both the thermal and nonthermal components, as well as the lack of an outer shell of the SNR. However, the real situation in the region is likely to be more complicated. We find that a partially round soft X-ray-emitting clump with distinct spectral properties may result from a separate oxygen-rich remnant. These results provide a rare glimpse into the SNR structure and evolution in a region of recent star formation.

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