The X-ray Properties of Supernova Remnants in Nearby Galaxies
Knox S. Long, William P. Blair, Kip D. Kuntz, & P. Frank Winkler

Abstract

More extragalactic SNRs have been detected in X-rays in nearby galaxies than in the Milky Way. Most of the X-ray detected SNRs were first identified optically, and then detected as soft X-ray sources in deep imaging observations with Chandra and sometimes XMM. Here, we discuss the large X-ray samples of SNRs in M33, M51, M63, and M101, with the goal of understanding which SNRs are detected in X-rays and which are not. Not surprisingly perhaps, most of the SNRs in these galaxies are middle-aged SNRs; very few analogs of Cas A or other young objects have been found. Trends of X-ray luminosity with diameter are absent, probably because the total amount of swept up material is the dominant factor in determining the X-ray luminosity of a SNR at a particular time. SNRs expanding into high density media evolve rapidly and have X-ray luminosities that peak at small diameters, whereas those expanding into lower density media evolve more slowly and have luminosities that peak later.

How are extragalactic SNRs identified

Most are identified optically, as emission nebulae with [S II]:Hα ratios that are higher (>0.4) than H II regions (<0.1).

Examples of SNRs in M83

Two regions in M83 as observed in (from left to right) (1) [Fe II] 1.644 μm, (2) Hα, [S II], [O III] (RGB) with stars subtracted, and (3) I,V,B broadband, all with HST/WFC3, (4) X-rays with Chandra (RGB=soft, medium, and hard) and (5) 20 cm radio with ATCA. SNRs identified on the basis of high [S II]:Hα ratios are indicated in green, with the smaller circles being 2" in diameter. Many of the SNRs in M83 are detected either as X-ray or radio sources as well. In the top panels, two SNRs apparently behind dust look harder (green) in the Chandra tile. A SNR identified on the basis of strong [Fe II] emission is indicated in magenta.

Deep X-ray observations with Chandra regularly detect SNRs in Nearby Galaxies

• M33
  • 88 of the 137 SNR candidates detected in the 1.4 Msec Chandra ACIS survey (Long+10)
  • M83
  • There are approximately 296 optically identified SNRs in M83
  • Of the 387 X-ray sources detected within the D25 diameter of M83 in deep 730 ksec Chandra observations, 87 aligned with SNRs (Long+14)
  • M51
  • Prior to Chandra there was no optical SNR catalog for M51
  • HST observations conducted in concert with deep 850 ks Chandra observations reveal 80 optical SNR candidates
  • Of these, about 40 are spatially coincident with Chandra X-ray sources
  • Of these, about 40 are spatially coincident with Chandra X-ray sources
  • M101
  • There are about 149 optically identified SNR candidates in M101, as a result of a combination of ground-based and new HST observations
  • Of these, about 40 are optically identified SNRs
  • Although a few new extragalactic SNRs have been identified with Chandra, most X-ray SNRs are so faint that direct X-ray identifications can generally not be made.

The X-ray proper es of Supernova Remnants in Nearby Galaxies

We thank NASA for supporting this work through Chandra Award Nos. GO2-13103 issued by the CXC, which is administered by SAO, and HST grant GO 12762, provided by NASA through the STScI, which is operated by AURA, Inc., under contract NAS5-26555.