Radio and X-ray Observations of the Northwestern Rim of the Galactic Supernova Remnant G156.2+5.7

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ABSTRACT

We present a broadband X-ray spectral study of the northwestern rim of the Galactic supernova remnant (SNR) G156.2+5.7. This SNR belongs to the class of sources which feature a significant non-thermal component to their observed X-ray emission. Recent X-ray observations have established that the non-thermal X-ray emission is broadly localized to the northwestern region of the SNR but a true understanding of the process responsible for this emission has yet to be achieved. To investigate a possible synchrotron origin for this emission, we are analyzing archival X-ray observations made of this northwestern rim with *XMM-Newton* and RXTE as well as radio observations made with the 21-Meter Morehead State University Radio Telescope and Space Tracking Antenna.

Figure 1: The Morehead State University 21-Meter Space Tracking Antenna (STA).

Introduction

The 21-Meter Space Tracking Antenna (STA) at Morehead State University is currently conducting a multi-frequency (chiefly survey of all known Galactic supernova remnants (SNRs) located in Declination north of ~-20° (see Figure 1 and Malphrus et al. 2008 for a detailed description of the STA). This survey concentrates on observing large and faint radio SNRs which are difficult to observe by interferometric arrays as well as other SNRs which have been in general poorly studied at radio frequencies. Data from observations made at other wavelengths (primarily X-ray) are incorporated into the analyses to help advance our understanding of both SNRs and SNR-related phenomena. To illustrate this work, we present an analysis of radio and X-ray observations made of G156.2+5.7, a Galactic SNR known to possess a significant non-thermal component to its X-ray emission.

G156.2+5.7

The Galactic SNR G156.2+5.7 was discovered during the ROSAT all-sky survey (Pfeffermann et al. 1991 – see Figure 2): the source has a large angular extent (~110 arcmin in diameter) and the X-ray morphology may be described as a diffuse high surface brightness disk. This morphology contrasts with the observed radio morphology, which features two strongly polarized rims (consistent with synchrotron radiation) toward the northwestern and southern edges of the X-ray emission (Reich et al. 1992, Xu et al. 2007). Prior X-ray spectral analysis using data from observations made by ROSAT, ASCA, Ginga and RXTE (Yamauchi et al. 1993, 1999; Pannuti and Allen 2004) revealed the presence of a significant non-thermal component to the observed X-ray emission. Recently, Katsuda et al. (2009) presented an analysis of Suzaku observations of this SNR and argued that the hard X-ray emission is localized to the center and northwestern regions.

Observations and Data Reduction (see Table 1):

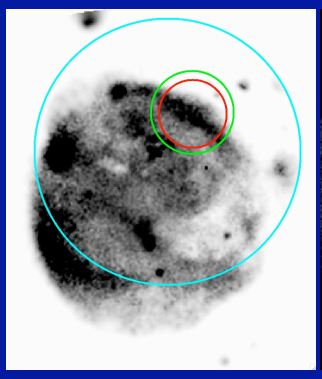
XMM-Newton Observations: MOS and PN datasets were reduced using the XMM-Newton Science Analysis Software (SAS) package Version 8.0.0: standard processing was conducted using the EMPROC and EPPROC tools. Spectra were extracted using the EVSELECT tool and spectra were grouped to a minimum of 20 counts per channel.

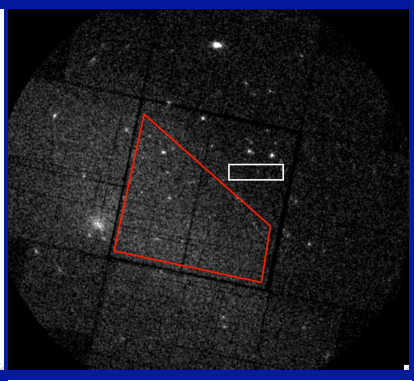
- *RXTE Observations: The PCA dataset was reduced using standard tools that filter for activity level of detectors and the location of G156.2+5.7 (both within 0.02° from the nominal pointing direction or location relative to limb of the Earth).*
- *STA Observations: The northwestern rim of G156.2+5.7 was observed by the STA during the fall of 2008 using the L-Band feed (1.4-1.7 GHz). Before and after the observation, a calibrating flux signal (corresponding to 38 Jy) was injected for reference while the STA is pointed at "cold" sky. Care was also taken to account for contaminating flux from the background radio galaxy 3C 130 (Hardcastle 1998) which was also sampled in the beam during the observation.*

Table 1: Summary of X-ray Observations

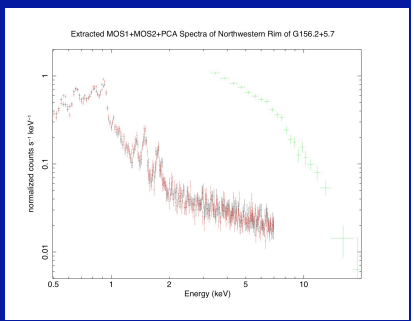
Observatory	ObsID or SeqID	Date	MOS1 Effective Exposure Time (sec)	MOS2 Effective Exposure Time (sec)	PN Effective Exposure Time (sec)	PCA Effective Exposure Time (sec)
XMM-Newton	0205970201	20 September 2004	47563	47575	41398	--
RXTE	50150-01	25 January 2002	--	--	--	16160

Results





Top Left -- Mosaiced ROSAT PSPC image of G156.2+5.7 with fields of view of the XMM-Newton observation, the STA observation and the RXTE observation indicated in red, green and cyan circles, respectively. Top Right -- Smoothed MOS1+MOS2 observation of the northwest rim: the region of source spectrum extraction is indicated in red and the region of the background spectrum extraction is indicated in white. Bottom Right – The extracted MOS1, MOS2 and PCA spectra plotted in black, red and green, respectively. Preliminary fits to the extracted spectra using a thermal model and a synchrotron model are consistent with the results presented by Katsuda et al. (2009). The normalization to the synchrotron component (from the STA observation) is 1 Jy at the frequency of 1 GHz.



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