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X-ray properties of G308.3-1.4 and its central compact object

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Abstract. We present a short *Chandra* observation that confirms a previous unidentified extended X-ray source, G308.3-1.4, as a new supernova remnant (SNR) in the Milky Way. Apart from identifying its SNR nature, a bright X-ray point source has also been discovered at the geometrical center. Its X-ray spectral properties are similar to those of a particular class of neutron star known as central compact objects (CCOs). On the other hand, the optical properties of this counterpart suggests it to be a late-type star. Together with the interesting ~ 1.4 hours X-ray periodicity found by *Chandra*, this system can possibly provide the first direct evidence of a compact binary survived in a supernova explosion.

Keywords. supernova remnants, X-rays

1. Introduction

Recently, we initiated an extensive identification campaign of unidentified extended ROSAT All-Sky Survey (RASS) objects (Hui *et al.* 2012). The brightest target in our campaign, G308.3-1.4, has already been known as a SNR candidate in the MOST SNR catalogue (Whiteoak 1992). But the limited photon statistics and the poor resolution of the RASS data do not allow any further probe of its X-ray emission properties. This has motivated us to observe G308.3-1.4 with the *Chandra* X-ray Observatory. The analysis of this observation is detailed in Hui *et al.* (2012); in these proceedings, we present a highlight of the major results.

2. Confirmation of G308.3-1.4 as a new SNR

The X-ray image of the field around G308.3-1.4 obtained by *Chandra* is displayed in Figure 1. An incomplete shell-like X-ray structure is found to be well-correlated with the radio shell structure. The radio contours are obtained from the 843 MHz Sydney University Molonglo Sky Survey (Bock *et al.* 1999). Together with the X-ray spectral analysis of the extended emission which suggests it is a shock-heated plasma with a temperature in a range of $kT \sim 0.6 - 1$ keV (see Table 2 and Fig. 8 in Hui *et al.* 2012), our observation unambiguously confirms G308.3-1.4 as a new SNR. A recent radio

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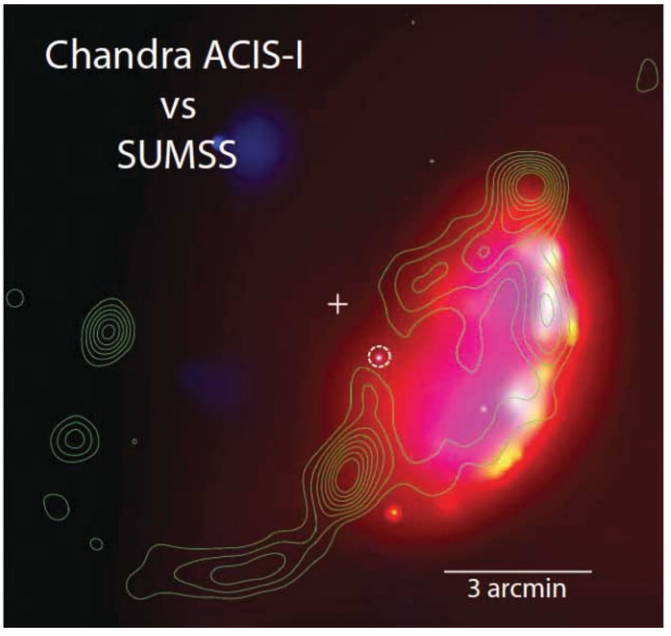

Figure 1. $10' \times 10'$ Chandra ACIS-I X-ray colour image of G308.3-1.4 (red: $0.5 - 1$ keV, green: $1 - 2$ keV, blue: $2 - 8$ keV). The binning factor of this image is $2''$. Adaptive smoothing has been applied to achieve a minimum signal-to-noise ratio of 3. The geometrical center inferred from the X-ray morphology is illustrated by the cross. A bright source which locates closest to the geometrical center is highlighted by the dash circle. Top is north and left is east.

investigation has come the same conclusion, suggesting G308.3-1.4 is a young to middle-aged SNR in the early adiabatic phase of evolution (De Horta *et al.* 2012).

3. Discovery of a new central compact object associated with G308.3-1.4

Apart from confirming the SNR nature of G308.3-1.4, our *Chandra* observation also enables us to search for the possible stellar remnant formed in the supernova explosion. Among 17 newly detected X-ray point sources (cf. Table 1 in Hui *et al.* 2012), the brightest source is the one located closest to the geometrical center of G308.3-1.4 (see Fig. 1). Its X-ray point source spectrum can be described by a double blackbody with the temperature of $kT_1 \simeq 0.1$ keV, $kT_2 \simeq 0.4$ keV and emitting areas of $R_1 \simeq 27 D_{\rm kpc}$ km and $R_2 \simeq 35 D_{\rm kpc}$ m respectively (see Fig. 2), where $D_{\rm kpc}$ is the distance to G308.3-1.4 in units of 1 kpc. These are similar to those of CCOs – one of the most enigmatic manifestations of neutron stars (cf. Hui *et al.* 2006, 2009, 2012). The column density inferred from the CCO spectrum is consistent with that for the remnant, which suggest the possible association between the CCO and G308.3-1.4. We proceeded to search for the possible X-ray periodic signals from CCO and have found an interesting periodicity candidate of $P \sim 1.4$ hrs (Fig. 3). Together with the spectral energy distribution of its identified optical/IR counterpart, which conforms with the spectrum of a M dwarf, our results suggest a possible direct evidence for compact binary that survived in a supernova explosion (Hui *et al.* 2012).

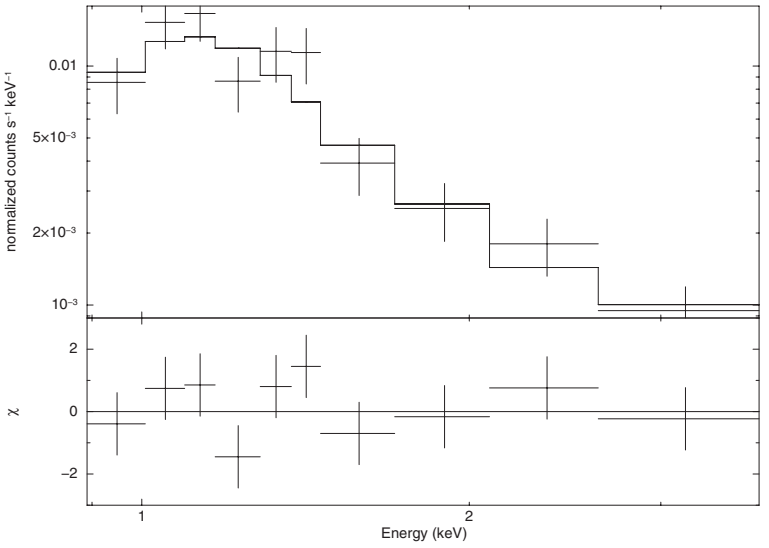

Figure 2. X-ray spectrum of the emission from the position of CCO as observed with ACIS-I with the best-fit double blackbody model (*upper panel*) and contributions to the χ^2 statistics (*lower panel*). The error bars represent 1σ uncertainties.

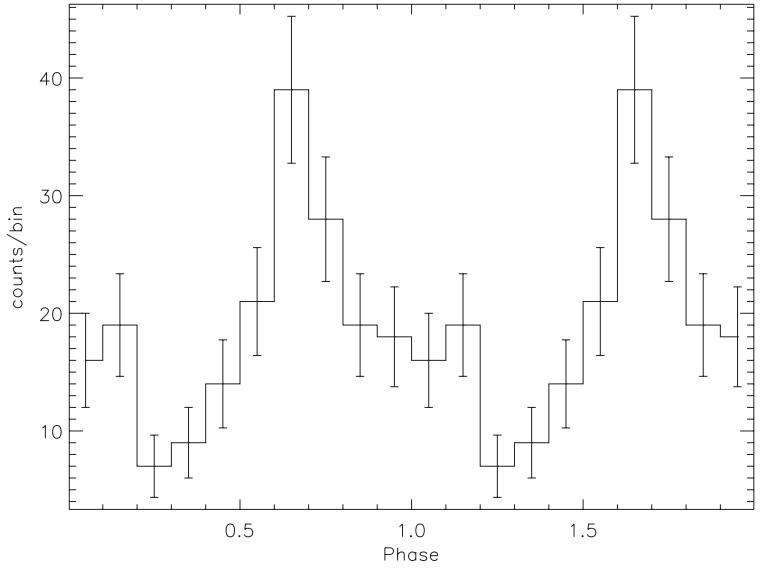

Figure 3. X-ray counts of CCO versus phase for a periodicity candidate of 1.4 hrs. Two periodic cycles are shown for clarity. The error bars represent 1σ uncertainties.

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