THE RADIO COUNTERPART OF THE X-RAY PULSAR WIND NEBULA IN THE SNR G0.9+0.1

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ABSTRACT

We report on new radio observations of the central nebula in the SNR G0.9+0.1 at 4.8 GHz and 8.6 GHz. These data unveil a highly clumpy structure of the radio nebula. Most of the radio features are uncorrelated with the X-ray emission. Not any point-like radio source is detected at the position of CXOU J174722.8-280915, the proposed neutron star. On the contrary, the X-ray source seems to lie within a small minimum in the radio emission.

Key words: X-rays; Radio continuum; Supernova remnants; G0.9+0.1.

1. INTRODUCTION

G0.9+0.1 (RA=$17^h47^m22^s.8$, dec= -28°09′15″, J2000) is a composite supernova remnant (SNR) which consists of a shell and a spectrally distinct inner nebula (Fig. 1), presumably a pulsar wind nebula, powered by the wind of relativistic e^-/e^+ pairs from a central pulsar (Helfand & Becker , 1987; La Rosa et al., 2000). In X-rays, the central pulsar wind nebula (PWN) was first detected with BeppoSAX (Mereghetti et al., 1998; Sidoli et el., 2000). These early detections suggested the presence of a young neutron star, although no coherent pulsations were observed. Based on ACIS Chandra 0.2-10.0 keV observations of the PWN, Gaensler et al. (2001) identified a faint semicircular arc, which they suggested to be part of a torus-like, and a jet-like feature. XMM-Newton observations in the 1.5-12.0 keV interval, show an amorphous nebula with a bright maximum towards the east of the PWN (Porquet et al., 2003). The faint, point-like hard X-ray source CXOU J174722.8-280915, detected at energies above 3 keV (shown as a white plus sign in the figures), is the best candidate for a central pulsar that would be powering the nebula.

We have conducted high resolution and high sensitivity interferometric radio observations to investigate the structure of the central nebula in the SNR G0.9+0.1, looking for correspondences with the associated X-ray emission. In addition, we have searched for the radio counterpart of the hard X-ray point-like source CXOU J174722.8-280915.

2. OBSERVATIONS

The radio continuum emission associated with the PWN in G0.9+0.1 was simultaneously observed at 4.8 GHz and at 8.6 GHz using the Australia Telescope Compact Array (ATCA) during 12 hours on 15/16 January 2004. The array was used in the 6B configuration, which records visibilities from baselines 214m to 6km. The 4.8 GHz ATCA data were combined with VLA archive data and with single dish data extracted from the Green Bank 4850 MHz Survey (Condon et al. , 1991) to produce a radio image with all spatial frequencies recovered. The angular resolution of the final images are $2''.9 \times 1''.6$ and $1''.5 \times 0''.8$ and the rms noise are 0.085 mJy/beam and 0.15 mJy/beam at 4.8 GHz and 8.6 GHz, respectively.

3. RESULTS AND CONCLUSIONS

The new high-resolution radio images of the central nebula in G0.9+0.1 have revealed interesting internal structures at different spatial scales, including arcs, maxima and holes. Although fainter in general and with a poorer signal-to-noise ratio, the general appearance of the nebula at 8.6 GHz is very similar to that at 4.8 GHz.

Fig.2 shows the radio image of G0.9+0.1 at 4.8 GHz (in greyscale) with overlapping contours corresponding to XMM-Newton X-ray emission in the range 6.0 and 12.0 keV as taken from Porquet et al. (2003). From this figure it can be noticed that the morphology of the PWN in both spectral regimes is quite different, being the correspondence between radio and X-ray emissions poor in general. The brightest part of the X-ray nebula lies in the easter half of the radio nebula. The point like source CXOU J174722.8-280915 do not have any counterpart in the radio band. On the contrary, the X-ray source seems

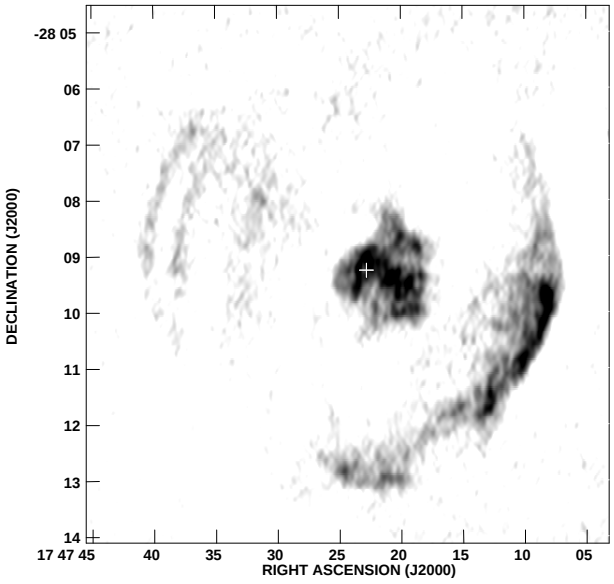

Figure 1. VLA image of the SNR G0.9+0.1 at 330 MHz (from Nord et al. 2004). The plus sign indicates the location of CXOU J174722.8-280915.

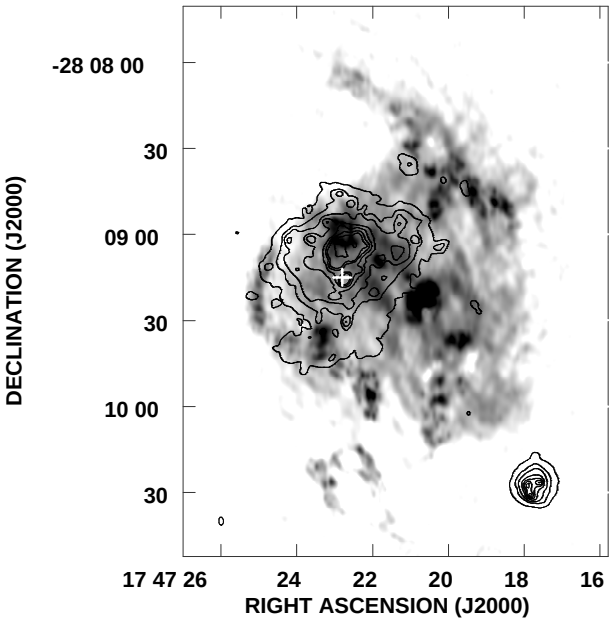

Figure 2. New radio image of G0.9+0.1 at 4.8 GHz (gray scale) overlaid with some contours of the XMM-Newton X-ray image in the range 6.0 to 12.0 keV (from Porquet et al. 2003).

to lie within a small minimum in the radio band. The eastern radio maximum in the PWN is shifted to the north from the X-ray maximum by about $3''$. A radio maximum observed near the southeast border of the nebula is the only one that coincides with one X-ray feature. Such feature was suggested by Gaensler et al. (2001) to be the termination of a jet.

In summary, the high resolution radio image of the central nebula in G0.9+0.1 reveals the existence of internal structures at different scales. The brighter central band of radio emission could be part of the torus-like feature early suggested based on Chandra X-ray data. The existence of a jet-like feature, however, is not evident in the radio image.

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